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RESEARCH REPORT

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An Effluent Charge for Sarangani Bay, Philippines: An Ex-ante Assessment

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This report looks at the implications of using an effluent charge to control industrial pollution in Sarangani Bay, the Philippines. It finds that an effluent charge of Pesos 6/kg (USD 0.11/kg) on BOD would bring about a 92% drop in industrial pollution. This would be sufficient for the waters of the bay to meet the national Class SB ambient pollution standard. The report also finds that the total abatement cost under this level of charge would be about Pesos 14 million (USD 265,000) per year less than the cost of the current command and control scheme. In light of these findings, the report recommends that the government of the Philippines should consider using such an economic instrument.

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March, 2003

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EXECUTIVE SUMMARY

This study assessed, in terms of cost savings and pollution discharge reductions, the use of effluent charge scheme as a management tool for protecting and maintaining good water quality in Sarangani Bay.

The ambient standard set by the Department of Environmental Studies and Natural Resources (DENR) served as a basis for assessing water quality of the Bay. The study assumed that compliance with the ambient standard (Class SB) would bring the level of pollution discharge to Sarangani Bay at a non-damaging level. This standard of maintaining a maximum BOD_5 ambient level of 5 mg/L was then used as the basis for setting the effluent charge level. The ambient requirement was converted in terms of mass through a deterministic water quality assessment model, to determine the allowable pollution discharge to the Bay. Results showed that Sarangani Bay could assimilate as much as 19,134 metric tonnes (t) of BOD_5 annually without exceeding the ambient standard for Class SB.

Given the existing annual discharge (6,114 t BOD_5) of the industrial sector, requiring the necessary reduction from this sector alone would mean bringing the level of abatement to 92%.

Based on the econometric simulations conducted, Pesos 6 (USD 0.11)/kg BOD_5 effluent charge level is sufficient to realize the needed industrial pollution reduction (i.e. 92%). Achieving the same level of reduction under a pure Command and Control (CAC) scheme, total abatement cost would amount to approximately Pesos 685 million (USD13 million). This implies that achieving the same level of pollution reduction target is approximately Pesos 14 million (USD 264,150) more expensive under the existing CAC scheme than one that complements CAC with effluent charge.

The considerations associated with direct regulation also apply to economic instruments. There is still a need to know what the harmful level is; the need for monitoring and enforcement remains and these factors also serve as the main argument that favors economic instruments over a pure CAC scheme. Economic instruments or other instruments will not deliver economic efficiency and achievement of environmental goal if the instruments are not enforced effectively. It is far from attainable under a pure CAC scheme to allocate sufficient manpower and technical resources to enhance enforcement and monitoring to ensure that a 92% industrial

pollution reduction will be achieved. If CAC could be complemented with effluent charge scheme, a certain proportion of revenue from pollution charges could be used to cover the implementation cost and/or used for self-construction of environmental protection agencies. In achieving economic efficiency and in effective environmental management, a Pesos 14 million (USD 264,150) abatement cost saving may not be significant compared to the experiences of other countries, but its value is appreciated.

1.0 INTRODUCTION

1.1 Background

In the past years, the South Cotabato-Sarangani-General Santos City (SOCSARGEN) area emerged as one of the most economically dynamic regions in the Philippines (Francisco et al. 1997). A significant factor propelling the growth in the area is the presence of Sarangani Bay, which provides various goods, and services that cater to the SOCSARGEN economy.

The Bay encloses an area of 449.22 km^2 and is bounded between Sarangani Province and the chartered city of General Santos (Figure 1). Besides providing a sanctuary for marine life, the Bay also offers a wide range of choices for recreational activities due to the presence of white-sand beaches, beautiful coral reefs and scuba diving sites. Several dive sites in good condition were identified in the Bay (Figure 2). The Bay provides one of Philippine's most strategically important ports for the shipment of agricultural products to and from the Southern Mindanao region. The ports in Sarangani Bay are directly located on international shipping routes that place SOCSARGEN in the mainstream of world trade. Presently, these beneficial economic usages of Sarangani Bay set the course for the medium- and long-term development plans of the SOCSARGEN area.

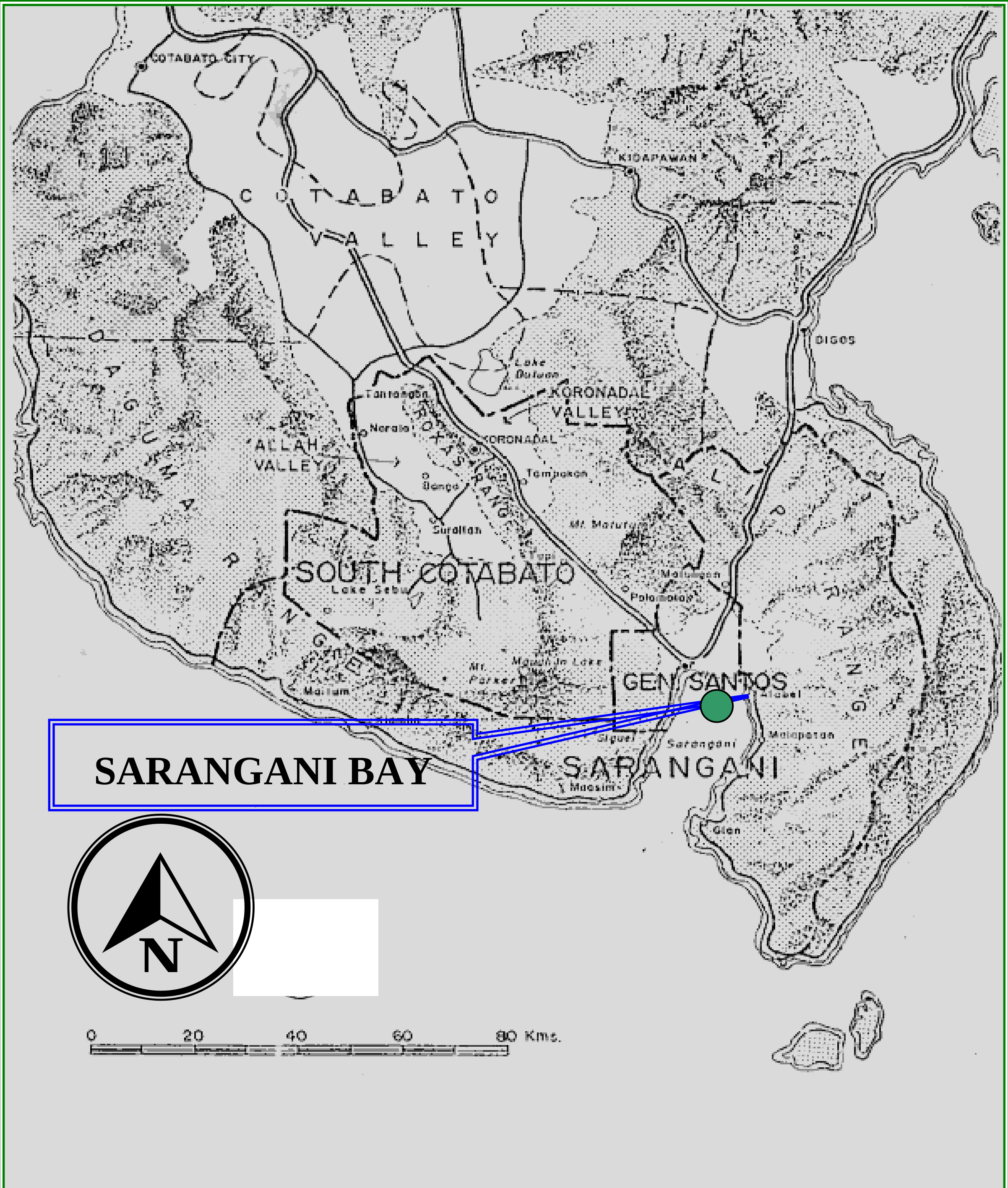
1.2 Management and Resource Use Conflicts

The sustainable management of Sarangani Bay is faced with conflicts in resource use and management strategies.

1.2.1 Management Conflict

In 1996, recognizing the role of Sarangani Bay in the growth of SOCSARGEN area, the Bay and the adjoining municipal waters of Maitum, Kiamba and Maasim were declared protected seascape for the purpose of protecting and maintaining its coastal and marine resources (under Proclamation No. 756).

Under this classification, the Bay is effectively categorized as Coastal/Marine Water Class SA where discharge of waste or effluent is absolutely prohibited. Ironically, by virtue of the previous and current usages of the Bay, it is effectively placed under Coastal/Marine Water Class SB, and not SA. Under the SB classification, a certain level of discharge can be allowed in the Bay along with the other beneficial usages. Related to this issue is the confusion on who should have administrative power over the Bay. Both General Santos City and Sarangani Province, prior to the proclamation in 1996, were initially granted the legal jurisdiction over the Bay. But by virtue of its proclamation as a protected seascape, the administrative power was consequently turned over to the Protected Area Management Bureau (PAMB). The Bureau, however, has not asserted its control over the management of the Bay.



Source: LBII 1991

Figure 1 Location of Sarangani Bay

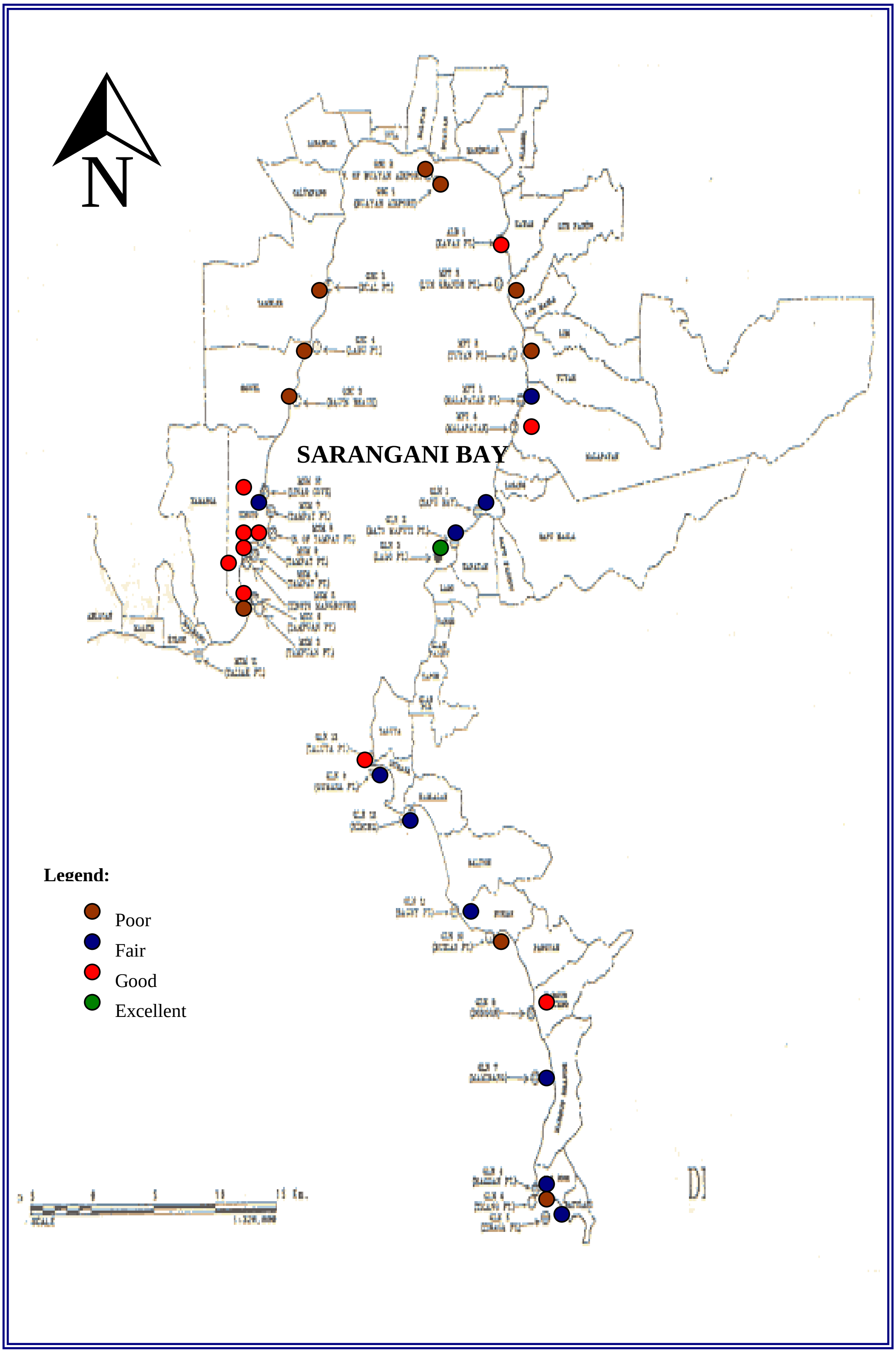


Figure 2. Dive Sites

1.2.2 Resource Use Conflict

Both General Santos City and Sarangani Province have the greatest stake and therefore, the greatest concern over the welfare and management of the Bay. However, although both are committed to preserving the Bay's water quality, there are conflicts as to how they should utilize the resources of the Bay.

General Santos City is moving towards industrialization and commercialization geared primarily to agro-based manufacturing and secondarily to eco-tourism, agro forestry, fruit production, livestock and cattle production (Francisco et al. 1997). However, the city is continually promoting the commercial fishing industry and its derivative industries like tuna canning and other fish product processing industries. The city allocated about 43 ha for agro-processing centers, which will be built along the shoreline of Sarangani Bay. Certain portions of Barangay[1] Labangal will also be converted into an industrial estate (Francisco et al. 1997).

In contrast, the economic activities in Sarangani Province are mainly agriculture-based, designed primarily to avoid significant pollution threats to the Bay. The long-term economic development plans of the province discourage the establishment of heavy industries in its municipalities. Instead, the province encourages developments of small-scale industries that rely mostly on craftsmanship and on the use of indigenous materials. Kiamba, for instance, is expected to specialize in eco-tourism (which capitalizes on the scenic beauty of Sarangani Bay), rattan, agro-forestry, as well as in commercial crops like rice, citrus, and other fruit trees. In the Glan zone, the major enterprises encouraged are cattle, coffee, corn, agro forestry and fruit trees (Francisco et al. 1997).

1.3 Existing Management Schemes

There are Command and Control (CAC) approaches set up by the Philippine government for the control of pollution discharges to water bodies. Primary among these regulations is the requirement to submit and comply with the environmental impact assessments for new industrial projects. After the production processes are in place, the water quality standards will then be applied.

Under the current structure of environmental regulation in the Philippines, there are two applicable water quality standards for the control of pollution in Sarangani Bay. One is the ambient standard and the other is effluent standard. For eight toxins and 12 conventional substances, these standards are known as DENR (Department of Environment and Natural Resources) Administrative Order Nos. 34 and 35 (DAO 34 & 35, respectively)**.**

1.3.1 Ambient Standards

The proclamation of Sarangani Bay as a protected area effectively places it under Coastal/Marine Water Class SA. Based on the ambient standard for this classification, Sarangani Bay is suitable for the propagation, survival and harvesting of shellfish for

[1] Barangay, also known as barrio, is the lowest political subdivision in the Philippines

commercial purposes; for tourist zones; national marine parks and reserves as well as for coral reef parks and reserves (DAO 34). However, according to the study of Woodward-Clyde Philippines Inc. (1996) based on the current beneficial usage of the Bay, it should have been declared as a Coastal/Marine Water Class SB instead of Class SA. Class SB is a less stringent standard suitable for an area used for bathing, swimming, skin diving, etc. as well as a spawning area for *Chanos chanos* (milkfish) and similar species. Appendix 1 provides details on the allowable ambient condition with reference to the standards.

The major tributaries of Sarangani Bay can be classified under Inland Water Class C. Under this classification, they serve as fishery water for the propagation and growth of fish and other aquatic resources; as recreational water class used for boating and similar activities; also as industry water supply for manufacturing processes after treatment.

1.3.2 Effluent Standards

The effluent standard sets the maximum allowable concentration of pollutants to be discharged from various sources. All point sources are subjected to these end-of-pipe effluent limits, which vary on the age of the facility and on the type of contaminants released. For new industrial point sources, the effluent limitations are more stringent than those for existing sources (Appendix 1).

The monitoring of discharges from stationary sources is the responsibility of both the permit holder and DENR. The firm submits regular effluent discharge reports to DENR and DENR, in turn, monitors ambient and effluent standards and enforces regulation through fines and closures when there are cases of persistent violators. Unfortunately, the monitoring capacity of DENR is limited due to the lack of manpower and other technical resources. Complicating the situation is the pressures, directly or indirectly, posed by local residents, not to issue closure orders in order to avoid disruption of employment, electricity and water supply and schooling (ADB 1997).

1.3.3 Integrated Coastal Management Plan (ICMP)

Since Sarangani Bay is a protected seascape, it is under the legal jurisdiction of National Integrated Protected Areas System (NIPAS) Act. This Act requires that “there shall be a general management planning strategy to serve as guide in formulating individual plans for each protected area.”

Sarangani Bay’s ICMP is developed by various stakeholders, including the Provincial and Municipal Governments of Sarangani Province; Municipality of General Santos City; law enforcers; Fisheries and Aquatic Resources Management Councils (FARMC); National Government Agencies (NGAs) such as DENR and DA-BFAR;as well as various NGOs and Pos,(-) and facilitated by Coastal Resource Management Project funded by USAID.

Programs identified under ICMP include: (1) habitat enhancement; (2) fisheries management; (3) management of pollution and water quality; (4) shoreline development; (5) tourism and enterprise development; (6) community development; (7) resettlement; (8) information, education and communication and (9) strengthening of the legal and institutional components. Under program number 3, the following specific Action Plan was formulated for the Management of Pollution and Water Quality:

a) Baseline information gathering

b) Establishment of water quality laboratory and monitoring system

c) Economic analyses of environment costs

d) Conduct of environmental policy research studies and application of market based instruments for pollution control

e) Construction of appropriate pollution control devices

f) Conduct of IEC activities that also include concerns on policies and standards.

Appendix 2 provides the details on the agencies involved and the target implementation years of the identified plan.

As provided under the NIPAS Law, the PAMB is in charge of the overall administration and acts as the policy-making body. DENR, as the primary agency in charge of environmental protection and management of marine and coastal environments, would provide guidance to PAMB with the participation of the Offices of the Regional Executive Director, the Provincial Environment and Natural Resources and the Protected Areas Superintendent. Various offices under the Province of Sarangani and General Santos City will be actively involved in the coastal management of the bay but the Coastal Management program itself will be housed under the Office of the Provincial/City/Municipal Agriculturist.

1.4 Potential Impacts of Unabated Worsening Pollution

Sarangani Bay serves as a fish basket for the coastal residents of General Santos City and Sarangani Province. There are more than 20,000 fishermen from General Santos City alone who depend directly on fishing activities in the bay while an estimated 30,000 families depend directly on the fishing industry in Sarangani Province (Woodward-Clyde Philippines 1996).

As pointed above, besides being a rich fishing ground, the Bay also provides recreational amenities like beautiful beaches and diving sites. Over 38 white sand beaches were identified within the Sarangani Province, 28 of which are located within the coastline of Sarangani Bay (Woodward-Clyde Philippines 1996).

It is important to remember that the Bay and its components do not operate in isolation. It involves complex interactions between biological and abiotic components. Continuous interference of a given element or process may have unexpected and far-reaching consequences for other elements and processes within the system. For instance, discharge of BOD_5 from industries and households is expected to cause the decrease of dissolved oxygen (DO) available for the anaerobic decomposition of organic substances thereby affecting the breeding activities of some tuna-like fishes in the Bay. Anecdotal accounts regarding this matter have been noted by marine resource experts in General Santos City (e.g. Portugal, personal communication). In some cases, the reduction of DO may not impose a serious threat on living organisms depending on that element for survival. However, when DO is used faster than it can be replenished, for example if it reaches 3-5 mg/liter, it can cause an adverse effect on fishes that require a relatively high oxygen concentration for their metabolic needs. The addition of enough oxygen demanding materials to the watercourse could cause the total depletion of DO and the death of all fishes. Furthermore, the absence of DO could result in the growth of microorganisms that produce by-products which cause foul odors in the water and its surrounding (Lamb 1985).

In addition, the presence of organic pollutants near the surface of the Bay will attract more microorganisms (e.g. bacteria) that are detrimental to human health. A survey conducted by MSU-General Santos City reported a high level of *Escherichia coli* in some areas of the bay especially in areas near industrial sites. Similar accounts of high *E. coli* level were found in their studies on bivalves that thrive near these areas. These bacteria, though normally present in human feces, will cause gastro-intestinal abnormalities such as diarrhea, dysentery, etc. when taken in. This issue will hamper the recreational value of the bay.

A decision to remain in the status quo (i.e. CAC alone) without further pollution control strategies might prove to be disastrous as can be seen by the fate of lakes, seas, and rivers around the country. In the study of Francisco et al. (1997) on Sarangani Bay, it was pointed out that indeed CAC is not effective in causing changes in the economic behavior of firms. In that same study, it was recommended that "there is a need to study the feasibility of using economic instruments such as emission charges or tradable permits to reduce water pollution in a key water resource such as Sarangani Bay".

The far-reaching impacts of the trade-off between the Bay's benefits and services and its conflicting use as a repository of wastes are further illustrated in Figure 3. The figure shows that all the activities in areas surrounding the Bay, including the existing issues confronting the Bay, affect its ambient condition together with the marine resources and services it provides. The negative manner and the extent to which these resources and services are affected inevitably compromise the economic well being of the surrounding areas.

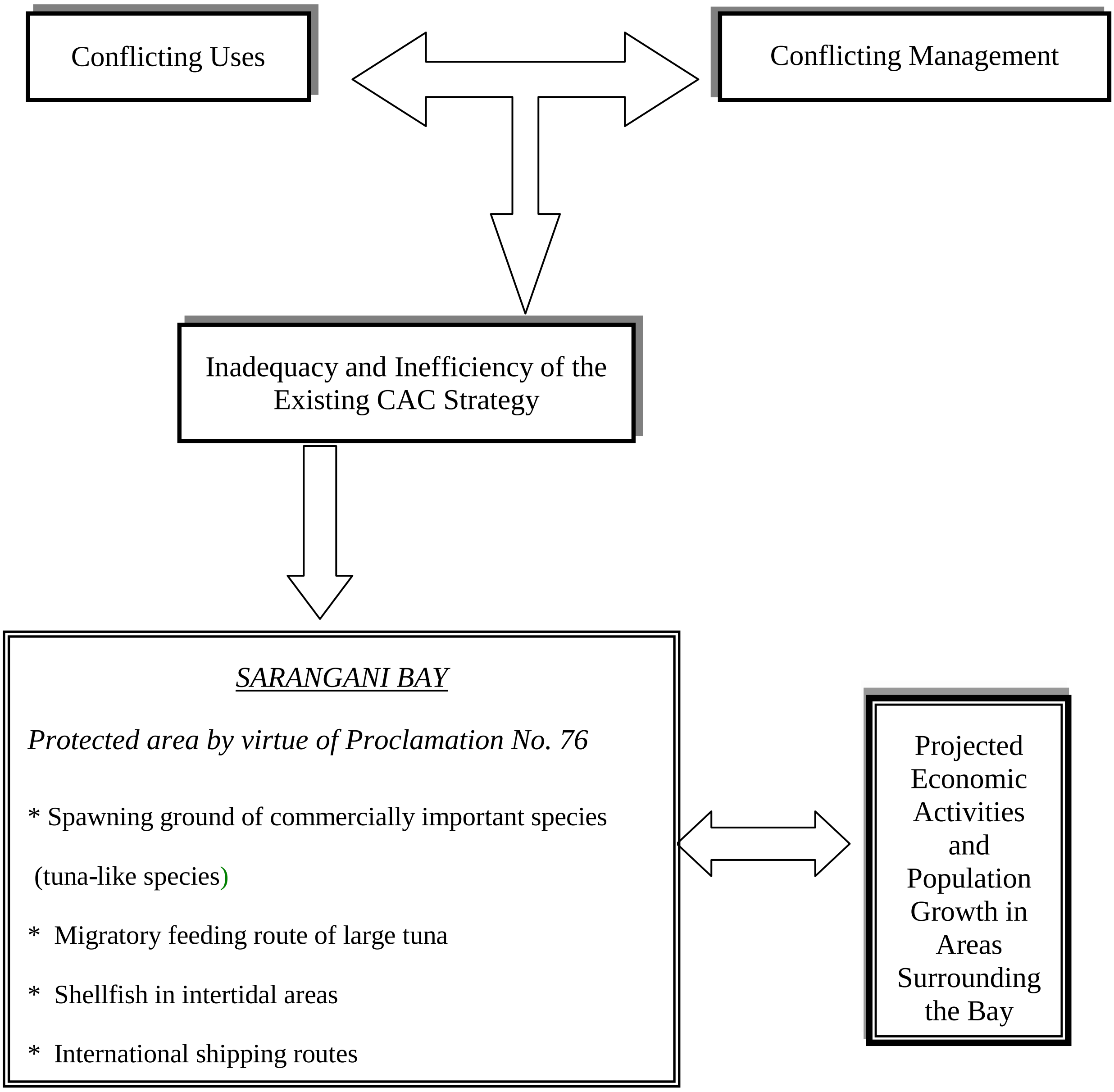


Figure 3. Complex Interactions of Sarangani Bay's Problems

2.0 RATIONALE, RESEARCH OBJECTIVES AND CONCEPTUAL FRAMEWORK

2.1 Rationale

The existing water quality of Sarangani Bay may not yet be at a very critical level, but considering the potential threats posed by the growing industrial and domestic activities, postponing action until something adverse happens might not be the best decision.

One advantage of the design of this effluent charge scheme being evaluated in the study is that the objective or goal is clear and explicit. This effluent charge is not simply aimed at reducing pollution discharge at any arbitrary level, but it is primarily designed to reduce pollution discharges at a level where the desirable or acceptable ambient condition of the Bay is maintained and protected.

The study is expected to fill up the information gaps on the implementation of the Sarangani Bay's Integrated Coastal Management Plan (ICMP). As discussed in Section 1.3.3 and Appendix 2, one of the identified major management objectives and strategy of the Plan is the internalization of environmental costs of development using market-based instruments.

Considering the conflicts in utilization and management of resources (Figure 3), this study, by nature of the "polluters pay" principle of market-based instruments is able to address some of the issues and concerns confronting Sarangani Bay management.

2.2 Research Objectives

The study aims to explore the use of economic instruments (EIs), particularly effluent charge schemes, for the management and control of pollution in Sarangani Bay. The acceptability of the policy option is evaluated based on environmental-effectiveness and cost-efficiency considerations.

In particular, the study hopes to estimate appropriate unit effluent charge for industrial polluters set on the basis of achieving environmental goals to protect Sarangani Bay coastal waters from indiscriminate pollution discharges.

Finally, the study intends to compare the impact of estimated effluent charge *vis-à-vis* the cost and pollution reduction achievements of the existing CAC regulations. The study will also assess the efficacy of the proposed DENR wastewater discharge permit fee by comparing it with the evaluation of the estimated effluent charge using the two criteria cited above.

2.3 Conceptual Framework

The theoretical premise in using market based instrument (MBI) is to internalize the cost of environmental damage by pricing the pollution-generating activity. This is known as the "polluters-pay-principle". This position is rooted in the belief that the polluter should bear the costs of control measures to maintain an acceptable level of environmental quality (Callan and Thomas 1996).

Following the notion that polluters should pay, the next logical question is, how much to pay. Economic efficiency normally requires that the pollution charge should bear a close relationship to the magnitude of damage caused by pollution. However, the pattern of damage from water pollution is normally very complicated. It is expected to combine health impacts and other impacts like amenity losses.

In practice, therefore, where correct environmental prices or marginal damage costs are unknown or uncertain and where abatement costs vary across sources, charges or fees are set on a unit of pollution where marginal abatement cost (MAC) are equalized across sources while leaving polluters free to select their form of abatement. This point, where MACs are equal across polluting sources and least-cost option is achieved, is called the equi-marginal principle of optimality. Polluters confronted with this added cost can either, continue polluting at the same level and pay the designated charge, or they can invest in some types of abatement technology to reduce pollutant releases and lower tax burdens.

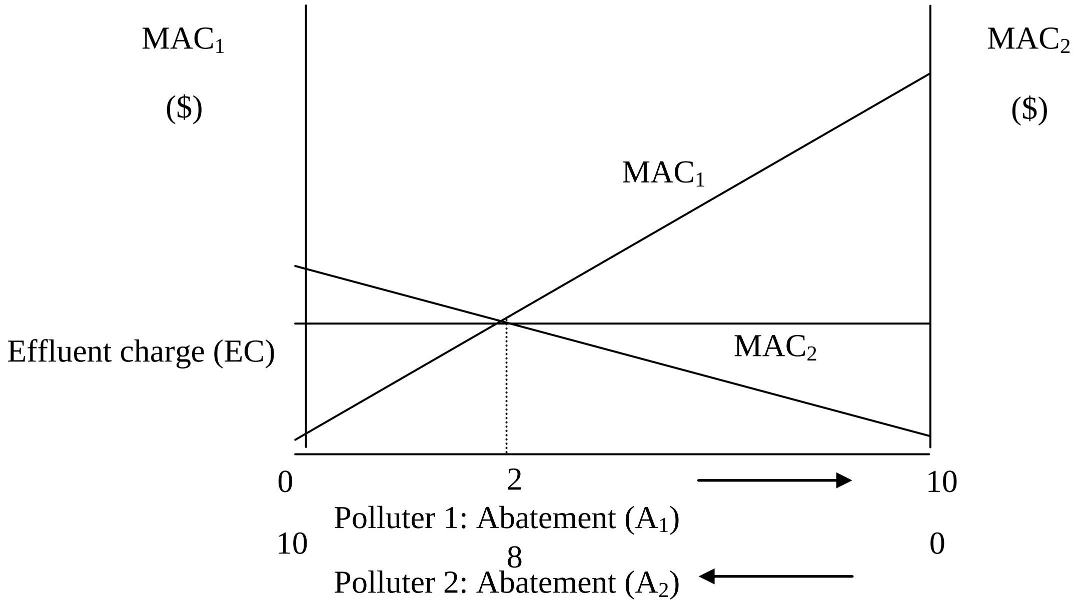


Figure 4. Effect of an Emission Charge

Figure 4 illustrates the MACs for Polluters 1 and 2 and the effluent charge imposed as represented by EC curve. The horizontal axis represents the level of abatement at any given cost and charge. Each polluter abates as long as his MAC < EC and pays the effluent charge on all units of pollutants not abated. The point where MAC1 = MAC2 = EC indicates the least-cost allocation of abatement responsibilities across the two polluters and satisfies the requirement for equi-marginal principle of optimality (Callan and Thomas 1996).

It is the market orientation of the effluent charge that provides the flexibility to achieve a cost-minimizing solution across polluters. The EI exploits the natural incentives to pursue a least-cost strategy. As a result, the low-cost abater, Polluter 2, performs much of the abating while Polluter 1 pays much higher charges to cover the greater damages it causes. The two polluters responded the way they did not because they were motivated by society's objectives but as it is in their best interest to do so. An added advantage of this approach is that it generates revenues for the government, which could be used to finance the enforcement and monitoring of the policy.

3.0 WATER POLLUTION DISCHARGE AND ITS EFFECT ON THE BAY'S WATER QUALITY

3.1 Inventory of Industrial Pollution Dischargers

The economic well being of the areas surrounding Sarangani Bay is basically dominated by a few agro-based industrial sectors such as tuna and fruit canning, livestock and other food manufacturing industries. These same sectors, according to previous studies like Francisco et al. (1997), Woodward-Clyde Philippines, Inc. (1996) and LBII (1991) are also considered as the major contributors of pollution in Sarangani Bay. However, as in any growing economy, there are various other derivative industries operating in the area. Table 1, based on the data of City Planning Development Office (CPDO) and National Statistics Office (NSO), shows that there are more than one thousand industries operating in areas surrounding Sarangani Bay. However, DENR and City ENR offices focus their monitoring mainly on sectors classified as major contributors of pollution. Based on available information from all sources, there are approximately 68 establishments in General Santos City that can be classified as major contributors of industrial pollution. From previous studies and the availability of reliable baseline information necessary for this exercise, this study focused on the 68 establishments (Table 1). All pollution and cost estimates that follow hereafter refer to these 68 establishments, considered and referred to as major industrial pollution dischargers.

Table 1 shows the types and numbers of industries that were included in the estimation of pollution load being discharged into Sarangani Bay. The estimation is based on the information provided by NSO, DENR, Planning Development Offices (Gen. Santos and Sarangani), business chambers as well as other government and non-government agencies.

The inventory includes data on the type of industry, scale of production, type of technology or process of production, raw materials used, the age of the plant, location, the discharge point, types of water pollution control devices, cost of control, efficiency of the control device, lifespan of the device, year the device started operation, wastewater volume, effluent concentration and other pertinent data. However, not all of the industries included in the inventory contain complete information as listed above. There are some establishments with very little or no information at all except for the name and location of their businesses.

As shown in Table 1**,** most types of business operations that pose potential threats to Sarangani Bay are agro-industrial in nature. Tuna canning and other seafood processing is a major, if not the largest, sector in the area. In the case of Sarangani Province, aside from the livestock sector and prawn farming, there are no other industries that pose significant threats to the Bay. All the industries listed in Table 1 are located in General Santos City.

Manufacturing industries such as fish canneries, cold storage and cobox plant occupy zones along the coastlines from Calumpang to Labangal to Tambler as these areas have been designated for industrial use since 1970 (Figure 5). Based on the 10-year development plan for General Santos City, they aim to further allocate 1,710.46 ha (3.19%) of the city's total land area for industrial use. It is a substantial increase from the existing industrial area of 313.84 ha. Concentration of the industrial zone will be in the southwestern part of the city towards Sarangani Bay (CPDO 2000).

Major Sectors Not Considered in the Study

- Prawn and fishponds proliferate around the coast; 297 hectares of land area is devoted for inland fishing/prawn farms (CPDO 2000).

- Aside from the public agro-fish port, there are other private ports used for the shipment of the companies' products. Private ports are not included in the study because of insufficient data since DENR and other monitoring agencies are not monitoring them.

The types of wastes, which may reach the sea from port-related activities, include garbage, wastes from livestock cargo, perishable products such as grain and cereals, chemicals, bilge water, washdown water and oil spills. (IEMP 1997).

- There are other tuna canners that use their own vessels to catch tuna. The wastes coming from cleaning and washing/operating the vessel is not included in the calculation.

- There are other fish and seafood processors who have their own vessels to do their processing illegally. In this way, they discharge their wastes directly into drainage channels, which eventually end up at Sarangani Bay.

- There are 11 privately owned brackish water fishponds, 26 ice plants and 9 cold storage/freezers.

- By 1999, the city has 15 commercial-scale poultry farms and 83 cattle farms (CPDO 2000)

Table 1. Inventory of Potential Industries Discharging Their Wastewater at Sarangani Bay, 2001

Sector	*No. of Plants*	
	Total	*Major Industrial Polluters*
Sand and gravel quarrying	78	0
Prawn Production	15	0
Livestock		
Hogs	50	44
Poultry	41	0
Cattle	9	0
Food		
Slaughtering	2	2
Poultry Dressing Plants	4	2
Tuna Canning	7	7
Fish and Other Seafood Processing	16	6
Manufacture of Fish Paste and Fish Sauce	1	0
Production of Fishmeal/Prawn Feds	3	1
Manufacture of Milk	1	0
Manufacture of Ice Cream and Other Flavored Ices	6	0
Grain Processing	13	1
Production of Prepared Animal Feeds	6	0
Beverage	4	1
Bakeshop	85	0
Production of Crude Coconut Oil	2	1
Noodles	6	0
Nata de Coco	7	0
Iceplant	9	0

continued

Table 1 continued

Miscellaneous	18	1
Box Manufacturing	4	1
Fertilizer Manufacturing	3	0
Aluminum & Metals Manufacturing	6	0
Ship Construction and Repair	9	0
Retailers		
Meat and Poultry	90	0
Fish and Other Seafood	320	0
LPG and Other Fuel Products	20	0
Restaurants	344	0
Hotels and Resorts	52	0
Hospitals and Clinics	6	0
Tin Can Manufacturing	5	0
Fish port and Public Market	2	1
Other Service Sectors	7	0
TOTAL	1,251	68

Source of Basic Information: City Planning Office-Gen. Santos City

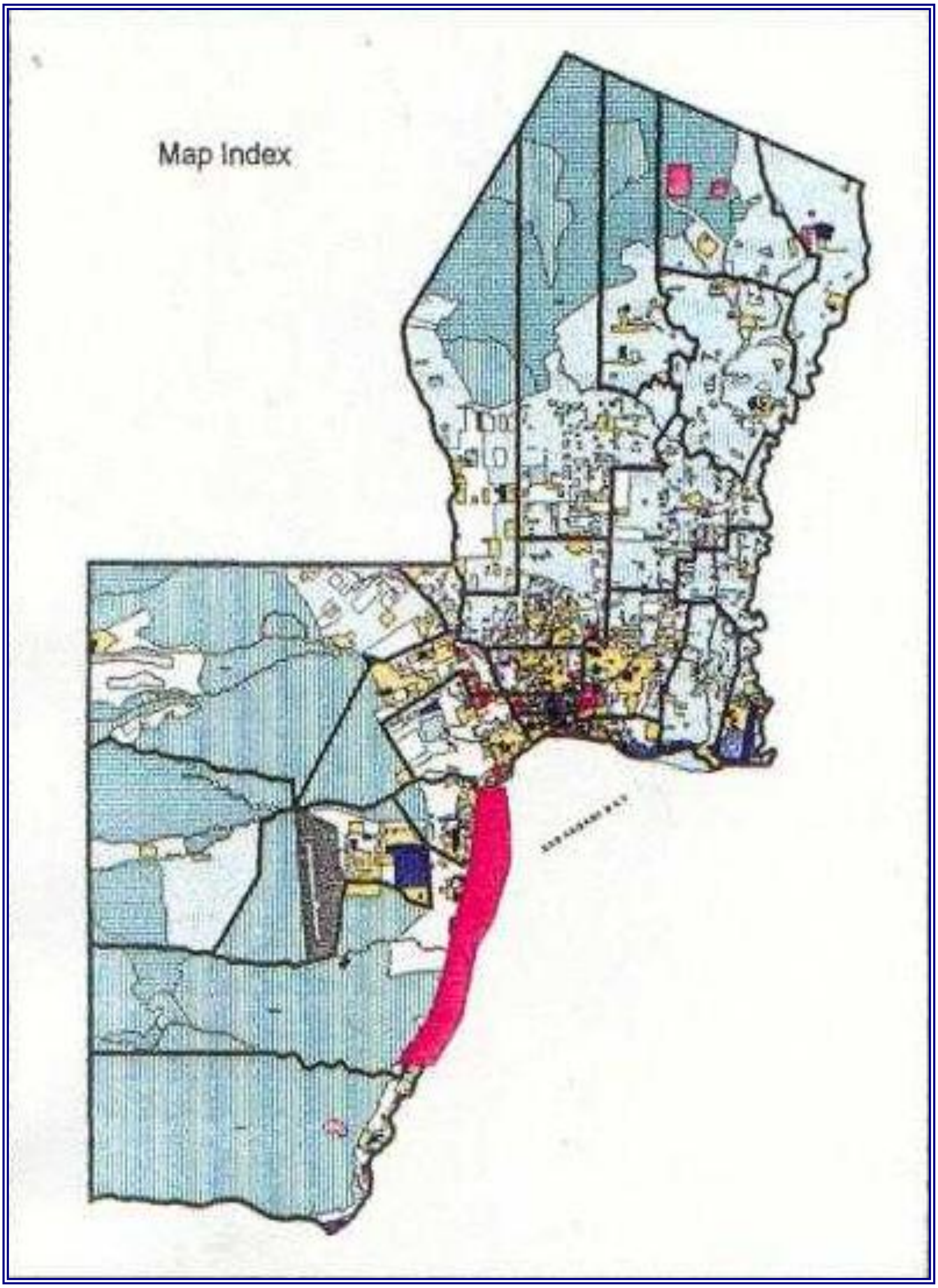


Figure 5. Location of Major Industrial Establishments in General Santos City

3.2 Baseline Information of Pollution Load

3.2.1 Formula Used

Industrial Discharge

The study relies on four sets of procedures and estimates for BOD_5 loadings. These include coefficients provided by (a) World Health Organization (WHO) Rapid Assessment Methodology; (b) effluent factors generated from a Philippine industrial survey conducted by Industrial Environment Management Project (IEMP); (c) wastewater sampling by plant levels, as reported in the Pollution Control Officer (PCO) Quarterly Report, DENR Monitoring Report and the Permit to Operate Wastewater Treatment Facility and; (d) Industrial Pollution projection system or IPPS from World Bank database.

The formula used in calculating the discharges for each set are as follows:

a) WHO Rapid Assessment

BOD_5 Load = Process rate x Effluent factor

Where:

Process rate - Production volume or raw materials used

Effluent factor - rate of pollutant generated per unit of product or raw material

b) Local-level factors

The formula used is similar to that of WHO Rapid Assessment, but the effluent factors used in the estimation are different. Whereas WHO factors are based on internationally derived coefficients, the local level pollution factors are based on data of local enterprises.

These factors are sectoral averages from industries around the country derived from a 1998 Philippine industrial pollution survey conducted by Industrial and Environmental Management Project (IEMP).

c) Plant-level

BOD_5 Load = Volumetric flow rate x Effluent concentration x No. of working days in a year

Whereas local-level estimate (refer to (b) above) uses sectoral averages, plant-level utilizes actual monitoring information of the characteristic of the plant's wastewater based on laboratory results.

The study extracted the plant's wastewater laboratory results from the following sources that can be gathered from City ENR and DENR Offices:

i) Inspection Reports - these are the duly accomplished forms filled up by City ENR personnel after they carry out their monitoring activities of the existing industries under their jurisdiction.

ii) Pollution Control Officer (PCO) Quarterly Report contains information on the actual level of production for a given period. It contains actual wastewater volume of discharge too. It also identifies the receiving body of wastewater effluent. This report shows the pollution parameters for a particular quarter too.

d) Industrial Pollution Projection System (IPPS)

IPPS is a modeling system, which combines data from industrial activity (such as production and employment) with data on pollution discharges to calculate pollution intensity factors (WB website).

The IPPS calculation, like the three other methodologies above, is straightforward. Pollution estimate is derived by multiplying the pollution intensity coefficients for BOD_5 by the number of employees in each industrial plant.

Except for the (effluent) coefficient used in procedure (c), the BOD_5 (influent) coefficients for the three other methodologies are adjusted by 50% to account for the level of abatement. The 50% average rate of reduction is based on Philippine's industrial pollution studies such as IEMP, IEPC and ENRAP. Table 2 lists down the unadjusted (or influent) coefficients used in the estimation.

In most cases, estimates using IEMP and WHO Rapid Assessment coefficients are very close, and in some instances, even the plant-level and IPPS coefficients come close to these two. But more often, the plant level estimate registers an extremely low BOD_5 calculation.

For this exercise, the final BOD_5 load estimate is derived based on the average value from the given coefficients, leaving out the lower extreme value/s. In some cases, without the necessary data, only one among the four methodologies can be estimated. Hence, this value is considered the final estimate.

The estimates cover the sectors including swine production, tuna canning, fish and other seafood processing, slaughtering, poultry dressing plants, grain processing, softdrink manufacturing, crude oil manufacturing, production of fishmeal, banana chips manufacturing, box manufacturing and, fish port complex. Overall, there are 68 plants included in the estimation (Table 1).

Table 2. BOD_5 Influent Coefficients for Several Sectors

Sector	*BOD_5 Influent Coefficients*				
	IPPS	*Phil. Coefficients*		*WHO Coefficients*	
	(kg/'000 employee)	*Rate*	*Unit*	*Rate*	*Unit*
Livestock					
Hogs		36.37	kg/head	32.90	kg/head
Food Manufacturing					
Slaughtering	3,258	2.52	kg/m^3 WW	10.90	kg/t LWK
Poultry Dressing Plant	3,258	0.65	kg/m^3. WW	11.90	kg/1000 birds
Tuna Canning	38,528	30.33	kg/t raw tuna	13.40	kg/t product
Fish & Other Seafood Processing	38,528	1.98	kg/t product		
Production of Fishmeal/Prawn feeds				62.20	kg/t product
Grain Processing	1.45			7.30	kg/t product
Beverage		0.04	kg/case		
Production of crude coconut oil	43,534	12.90	kg/t product		
Miscellaneous	1.61	7.41	kg/t product	12.50	
Box Manufacturing	5,166	0.08	kg/t box	15.00	kg/t product
Fish port and Public Market		300	mg/L		

Note: IPPS = Industrial Pollution Projection System

Phil. = Philippines

WHO = World Health Organization

WW = wastewater

LWK = live weight killed

Other BOD_5 Pollution Sources

Pollution load from other sources is computed based on the BOD_5 level of the tributaries of the bay at their downstream portion and their estimated annual water discharges or flow (Table 3). It is assumed that the BOD_5 level at this point of the river represents the BOD_5 contributed by other sources including domestic (non-coastal) and agricultural runoff, etc. which drained directly to the river. This is also the BOD_5 that enters into the bay thereby contributing to its existing BOD_5 level. The pollution load from these sources is computed to be the product of the BOD_5 concentration of the tributary at that point and its water volume discharge.

Table 3. Characteristics of Sarangani Bay's Major Tributaries

Tributary	*Temperature* $^{0}C^{1}$	*Flow* (m^3/yr)	BOD_5 $(mg/L)^2$	*Drainage Area* (km^2)
Silway River	28.4	115,421,760	10.5	424.18
Buayan River	30.2	184,800,960	4.6	1,049.3
Lun River	30.8	23,336,640	4.3	
Siguel River	29.0	83,255,040	3.9	356.2

Source: IEMP 1997. Final Report on the Initial Water Quality Assessment of Sarangani Bay

For the domestic discharges from coastal communities, the ENRAP-SOCSARGEN estimate of household BOD_5 discharge from Sarangani Province and General Santos City for the year 2000 is adapted. According to the Sarangani Bay wide plan report, 41 % of the population in General Santos City and Sarangani province is located in coastal barangays. Appendix 3 provides information on the rate of growth and actual population of areas surrounding Sarangani Bay.

All these pollution values, taken together, are then used to determine the impact of the current pollution discharges on the water quality of Sarangani Bay.

3.2.2 Pollution Load

Based on the above computations, it is estimated that the majority of pollution discharged to the bay comes from agricultural, domestic and other non-industrial sources. About 71% of the total pollution load in the bay comes from these sources (Table 4). The remaining discharge of 29% is attributed to the industry sector which comprises 68 major establishments. However, it should be noted that the industrial pollution load estimate is considered to be low-bound since the small and medium scale industries were not included in the estimation due to lack of baseline information. As mentioned earlier, monitoring of wastewater by environmental agencies are mainly focused on major contributors of pollution.

Table 4. Total BOD_5 Discharged in Sarangani Bay

Source	*Current Flow* (m^3/year)	*BOD_5* (t/year)	*Percent Distribution (%)*
Agriculture/Domestic Runoff through Tributaries & Other Sources			
Silway River	115,421,760	1,212	4.8
Buayan River	184,800,960	850	3.37
Lun River	23,336,640	100	0.40
Siguel River	83,255,040	325	1.29
Coastal Communities	65,150,199	15,360	60.84
Sub-Total		17,847	70.69
Major Industrial Polluters*	4,427,286	7,401	29.31
TOTAL	476,391,882	25,248	100

Note: Major industrial polluters* refer to the 68 large establishments.

Among the industry sectors considered, tuna-canning sector shows the highest pollution load estimate, followed by hog raising (Table 5). While the lowest BOD_5 contributor is the grain-processing sector with an estimated pollution load of 0.30 t/year.

The other major contributor of industrial pollution in Sarangani Bay is the livestock sector. Approximately 45 major hog raisers are operating in General Santos City with an average hog population of 1,000 to 11,000 heads at any one point in time. Wastes from piggeries usually come from pen cleaning and flushing, showers, spills and leaks of automatic nipple type waterer, pipes, and hoses. In few instances, decant wastewater from the impounding ponds is being used to irrigate the adjacent farms with sludge recovered from the waste treatment facility utilized as suitable organic fertilizers. The National Irrigation Administration has sealed off outlets where effluents from piggeries might enter , probably because of high pollutive effects of the effluents.

In General Santos City, most of the piggery farms are located at the industrial and agro-industrial zones in such areas as Conel, Katangawan, Apopong and Baluan. Figure 6 shows the relative distance of these farms from the Bay and river systems.

Table 5. BOD_5 Discharge by Major Industrial Polluters*

Sector	*BOD_5 (t/year)*	*% Share*
Livestock		
Hogs	2,155	29
Food Manufacturing		
Slaughtering	23	0.31
Poultry Dressing Plant	42	0.57
Tuna Canning	3,782	51
Fish & Other Seafood Processing	98	1.32
Production of Fishmeal/Prawn feeds	7	0.09
Grain Processing	.30	0.00
Beverage	146	1.97
Production of crude coco oil	615	8.32
Miscellaneous	10	0.13
Box Manufacturing	487	6.59
Fish Port and Public Market	35	1.48
TOTAL	**7,401**	**100**

Note: Major industrial polluters* refer to the 68 large establishments.

Together, the hog and tuna canning sectors contribute the largest share of pollution from industrial sources being discharged in the Bay (Table 5).

Although the pollution control officer (PCO) reports and DENR monitoring reports show that each cannery has invested in a waste treatment system such as biological treatment (ranging from activated sludge to lagoons), it has been observed that not all the systems are working efficiently. A study conducted by IEMP (1997) recorded that pollution control devices of tuna canning plants have not been designed to match volumes, BOD_5 discharge, area and retention times to achieve the desired treatment. Some processors even discharge wastes directly to the Bay. In the past, several tuna canneries have been issued with cease-and-desist order by DENR. According to LBII-CAMP (1991) it is probable that none of the canneries consistently meet DENR Water Quality Standard.

3.3 Link between Pollution Discharge and Ambient Condition

3.3.1 Oceanographic Characteristics of the Bay

In general, the current water quality of the bay is still within the standard set by DENR for Class SB and even Class SA coastal water. However, there are already signs of exceedance in some areas. Woodward-Clyde Philippines (1996) has already noted some “pollution hotspots” in areas mostly located near the mouth of the tributaries and near the coastline. This condition may be due to the oceanographic characteristics of the bay wherein there is very low flushing of organic pollutants out of the bay. This condition means that whatever wastes discharged into it will possibly remain near the shoreline or will remain concentrated in localized areas resulting in a continuous increase of BOD_5 in these areas.

In addition, according to the LBII study (1991), vertical mixing is not a significant phenomenon in the bay due to its homogeneous surface. This situation indicates that though the bay has a great volume of diluting saltwater, it is possible that the bay’s BOD_5 ambient level will exceed the ambient standard since organic wastes will just float at the surface, creating a surface plume of pollutants. This condition is critical since it is at the surface where most people have in contact with the bay and it is the surface that allows light to penetrate into the deeper portion of the bay. The presence of abundant supply of nutrients at the surface may increase abruptly and dramatically the population of algae thus blocking the light from penetrating into the deeper portion of the bay. In worst cases, this could lead to the death of light-sensitive organisms living beneath.

3.3.2 Impact of Industrial Pollution on Ambient Water Quality

The ultimate objective of improving the environmental control and regulation is to protect and maintain good water quality of Sarangani Bay and not just simply to aim for an arbitrary reduction of pollution discharges. The study defined good water quality in terms of compliance with the requirements (particularly BOD_5) for Class SB ambient standard. Although Sarangani Bay is administratively classified as Class SA, in reality, the existing and even the projected beneficial usages of the Bay effectively place it under the less stringent Class SB. Stakeholders from private and public sectors are more inclined to manage and utilize the Bay as a Class SB water type. Based on these considerations, the study decided to evaluate and aim for good water quality by meeting the Class SB ambient standard requirement.

Using a simple deterministic water quality assessment model by Viesmann and Hammer (1993), this section aims to calculate the allowable BOD_5 discharge and the consequent discharge reduction needed to maintain BOD_5 concentration level within the acceptable level of Class SB ambient standard.

By sheer complexity of large-scale phenomena taking place in an open system such as Sarangani Bay, uncertainty arises and since this is just a deterministic model which inevitably simplifies a lot of things, and with imperfect and incomplete data, the result from this model should be approached with caution. Despite this limitation - as Ravertz (Beder 1993) argued - in dealing with environmental problems, policies must be made despite uncertain facts and disputed values on issues for which the stakes are high and about which decisions are urgently needed.

Taking into consideration the environmental objective (i.e. maintaining Sarangani Bay's water quality at 5 mg/L BOD_5), the following formula is used to calculate the allowable pollution load that would give a change in the Bay's water quality equal to the standards:

BOD_{BR} = [5 + {Reaearation Rate (Temperature T)} x {Dissolved Oxygen at Saturation – Actual Dissolved Oxygen Present}] / [Deoxygenation Rate (Temperature T)]

Where:

BOD_{BR} = BOD_5 Allowable before Reaearation (to meet Class SB standard)

5 = Class SB standard for BOD_5 (in mg/L)

Reaearation Rate (Temperature T) = Rearation rate (at 20^0C) x $1.047^{\text{Temperature MIXTURE-20}}$

Rearation Rate (at 20^0C) = $(0.000025 \text{ x Current Flow}_{\text{SARANGANI}})^{1/2}/\text{Depth}^{3/2}$

$\text{Temperature}_{\text{MIXTURE}}$ = [($\text{Temperature}_{\text{SARANGANI}}$ x Current $\text{Flow}_{\text{SARANGANI}}$) + SUM ($\text{Temperature}_{\text{WASTEWATER}}$ x $\text{FlowRate}_{\text{WASTEWATER}}$)] / [$\text{CurrentFlow}_{\text{SARANGANI}}$ + SUM $\text{FlowRate}_{\text{WASTEWATER}}$]

Deoxygenation Rate (Temperature T) = Deoxygenation Rate (20^0C) x $1.047^{\text{Temperature MIXTURE-20}}$

The study assumes that homogeneous mixing between the pollutants and the seawater takes place at 1-m depth and at a distance of 20 m from the shoreline. Reaeration rate for the bay was estimated to be 0.66 day^{-1} at a temperature of 28.37^{o}C . Table 7 provides some of the basic information used in the calculation of the equations above.

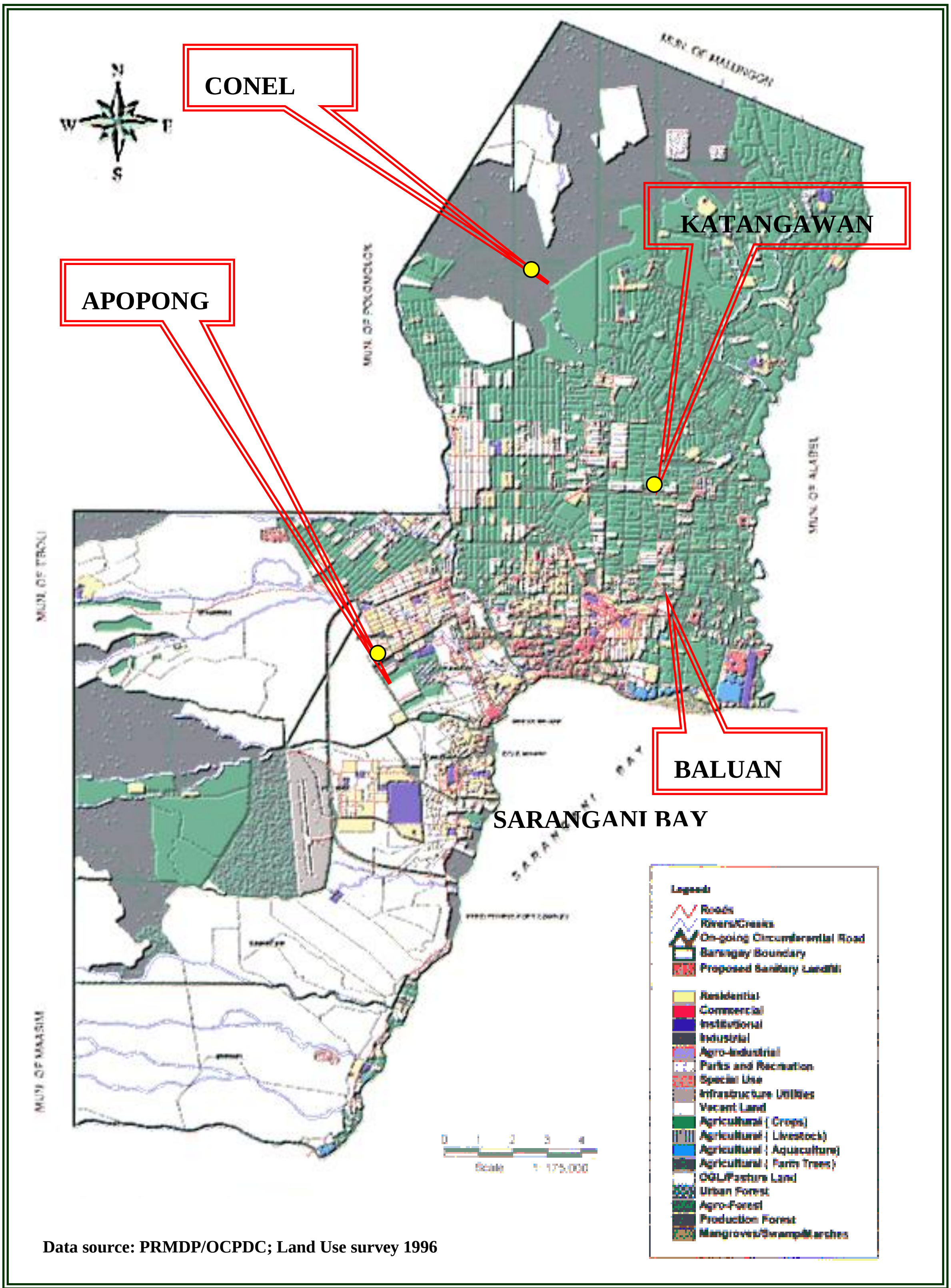


Figure 6. Location of Piggery Farms in General Santos City (OCPDC-GSC)

Table 6. Expected BOD_5 Discharge of Major Industrial Polluters if They Comply with Effluent Standard*

Sector	*WW Discharge Volume* *(m^3/year)*	*BOD_5* *(t/year)*
Hog Raising	1,816,868	91
Slaughtering	23,299	1
Poultry Dressing	76,830	4
Tuna Canning	1,613,040	81
Fish & Other Seafood Processing	79,169	4
Production of Fishmeal	410	.02
Grain Processing	15,600	.78
Beverage	203,904	10
Production of Crude Coconut Oil	427,780	21
Banana Chips Mfg.	5,200	.26
Paper Products Mfg.	4,586	.23
Fish Port Complex	160,600	8
TOTAL/AVERAGE	**4,427,286**	**221**

Note: Major industrial polluters* refer to the 68 large establishments.

If the industries covered in the study comply with the effluent standard, Table 6 shows the expected industrial pollution discharge given the existing level of production. The BOD_5 estimate in Table 6 is derived using the ff. formula:

$$\text{Sectoral Expected } BOD_5 \text{ Discharge} = \sum_{i=1}^{n} (WW_i \times 50)$$

where:

WW = volumetric discharge of plant i (in m^3/yr)

50 = BOD_5 effluent standard for Class SB coastal water (in mg/L)

Table 7. Sarangani Bay's Hydrological Characteristics

Parameters	*Unit*	*Value*
Surface Area	ha	44,900
Coastline	km	79
BOD_5	mg/L	2.8
Temperature	^0C	29.1
Average Depth	m	350
Distance	m	20
Velocity	m/sec	2.46
Current Flow	m^3/sec	49.2
Reaeration (20)	day^{-1}	0.56
Reaeration(T)	day^{-1}	0.66

Source: Sarangani Bay Integrated Coastal Resource Management Plan

Results of the equations above are presented in Table 8. Considering Class SB ambient standard as environmental target, allowable ambient BOD_5 concentration level before reaeration is set at 11.58 mg/L. To convert this in terms of allowable BOD_5 discharge in terms of metric tonnes 11.58 is multiplied by the sum of the total wastewater volume and the Sarangani Bay flow rate and then subtracted from the natural BOD_5 level of the bay.

Results in Table 8 show that a maximum discharge of approximately 19,134 metric tonnes (t) of BOD_5 should not be exceeded in order to maintain an ambient level in compliance with Class SB standard.

Table 8. Allowable Discharge to Achieve Ambient Standard Compliance

Management Goal	*BOD_5 Requirement (mg/L)*		*Total Current Flow ('000 m^3 /year)*	*BOD_5 Level (t/year)*		
	Before Re-aeration	*After Re-aeration*		*Before Re-aeration*	*Natural Level*	*Allowable*
Class SB	11.58	5.0	2,027,963	23,479	4,344	**19,134**

Considering that the existing total annual BOD_5 being discharged into the Bay is estimated to be 25,248 t (as shown in Tables 4 and 9), there is therefore a need to eliminate 6,114 t BOD_5 in order to meet the allowable discharge level (19,134 t) for Class SB ambient standard (Table 9).

If the industrial sector is required to further reduce BOD_5 by 6,114 tonnes, the existing effluent discharge of 7,401 t/year should be reduced only to 1,287 t/year. Translated in terms of reduction rate, the existing industrial level of pollution abatement of 49% should increase up to 92% (Table 9). A higher rate of pollution reduction (i.e. 98%), beyond what is required to meet ambient standard, will be realized if all industries (i.e. the 68 establishments covered in the study) will comply with the effluent standard (Table 6).

Table 9. Existing and Allowable Effluent Discharges to Sarangani Bay

	Physical Estimates (t/year)
Existing Discharges[1]	**25,248**
Domestic Coastal Communities	2,487
Runoff from Agriculture & Non-Coastal Communities and Other Sources	15,360
Industries (from Major Contributors)	7,401
Total Allowable Discharge to Meet Class SB Ambient Standard[2]	**19,134**
% of Total Discharge	76%
Reduction Needed to Meet Class SB Ambient Standard[3]	**6,114**
% of Total Discharge	24%
Existing BOD_5 Generation & Discharge by Major Industrial Polluters	
Influent	14,630
Effluent	7,401
BOD Treated[4]	7,229
% Reduction[4]	**49%**
Allowable Industrial Discharge to Meet Class SB Ambient Standard[5]	1,287
% Reduction from Influent[5]	**92%**
Allowable Industrial Discharge to Meet Effluent Standard	221
% Reduction from Influent	98%

Notes:

1 Derived from Table 4.

2 Derived from Table 8.

3 Reduction Needed = Existing Discharges – Allowable Discharge to Meet Class SB Ambient Std.

4 BOD_5 Treated = Influent – Effluent

% Reduction = BOD_5 treated / Influent

[5] Allowable Industrial Discharge to meet Class SB Ambient Standard = (Effluent – Reduction Needed to Meet Class SB Standard)

% Reduction = (Influent - Allowable Industrial Discharge to Meet Class SB standard) / Influent

4.0 ESTIMATION AND ASSESSMENT OF EFFLUENT CHARGE SCHEME FOR SARANGANI BAY

4.1 Cost Data

Industrial facilities can abate pollution by minimizing polluting activities or by diverting resources to cleanup. In either case, pollution reduction will render some cost to the industry (Dasgupta et al. 1996). For this study, the abatement or control cost is based on the end-of-pipe treatment cost normalized in terms of per unit BOD_5. Abatement costs are estimated by adding operations and maintenance expenditure to annualized or amortized services from abatement capital or what is otherwise known as the annual depreciation of capital. The amortized capital cost assumes that the value (capital plus interest) of the facility or the EOP technology is consumed over its lifetime in equal increments (Ebarvia 1994). A 10-year lifespan of the device is assumed and subsequently discounted using a 15% rate.

Data is generated from actual plant level cost figures as reported by the firms in their Permit to Operate Wastewater Treatment Facilities. In the absence of plant level information, it is derived through cost-transfer approach using local-level data from surveys conducted by Asian Development Bank (ADB), EMB (Environmental Management Bureau) – ENRAP (Environmental and Natural Resources Accounting Project) Technical Working Group. Table 10 shows some of the cost surveys conducted in the Philippines that are used in the study. The figures in the table are in 1998 prices at base year 1994.

In the study conducted by ADB (1997), results show substantial variability in the cost of treatment across plants in the same industry and across industries (Appendix 4). Similarly, the survey conducted by ENRAP-EMB Technical Working Group in 1999 on the control cost of industries around the country demonstrates this variability. Findings showed that the cost of control per ton of BOD_5 ranges widely from Pesos 0.50 to Pesos 3,000 (USD 0.01 to USD 56.60). The firm’s location, the type of contaminants it releases, the nature of its production, and the availability of technology are just some of the factors that affect the firm’s abatement cost.

Table 10. Control Cost Information from Various Philippine Cost Data Surveys

Sector	*Control Cost (Pesos/kg BOD_5)**		
	ENRAP-EMB TWG	*ADB*	*Gen San*
Slaughtering and meat packing	40.17	35.21	
Production, processing & preserving meat	63.47	35.21	
Processing & canning of fish & seafood	1.51	35.21	43.26
Canning/packing of fruits & fruit juices	74.24		
Mfr. of refined coco oil	3.28		
Mfr. of soft drink	52.67	53.64	
Mfr. of containers, boxes & paperboard	66.42		
Piggeries		44.43	

* In 1998 prices at base year 1994

Note: Mfr. = Manufacture

4.2 Cost Function and Equations

The study utilizes the cost functions developed by Dasgupta et al. (1996). The following variables were included in the formulation of the cost function.

$Cj = f(Wj, Ej/Ij, Ms, Xj)$ Equation 1

where:

Cj: Total annual cost of abatement for the plant

Wj: Total annual wastewater volume

Eji/Ij: Vector of effluent/influent ratios, which can be interpreted either as concentration ratios or volume ratios (since waste water volume is constant across influent and effluent for each plant, it cancels out of the concentration ratio).

Ms: Vector of input prices at the location of the plant (s).

Xj: Vector of relevant plant characteristics (sector, age, ownership, productive efficiency, etc.)

From the total cost function, marginal abatement cost function is derived as follows:

$$\frac{\partial Cj}{\partial E} = \frac{\partial f(Wj, Ej/Ij,}{\partial Ej} \qquad \text{Equation 2}$$

The study excludes the vector of input prices (Ms) because there are no available data on cross-regional price indices.

The abatement in the equations is measured by E/I, which reflects the percentage reduction in pollutant as it passes through from pre-abatement influent concentration (I) to post-abatement or treated effluent concentration (E).

In estimating cost using the variables wastewater and effluent-influent BOD_5 ratio, double log regressions are performed using a simple regression or constant elasticity model.

$$\ln C = \alpha_0 + \alpha_1 \ln W + \beta_1 \ln [E/I] + \varepsilon \qquad \text{Equation 3}$$

The type of industry is included in the regression run by using eleven dummy variables to represent the twelve industries covered in the study. Regression results show an adjusted R^2 of 92% and WW have a coefficient of 0.9356 with a standard error of 0.065. (Appendix 5) This coefficient implies that there is an expected increase in cost as wastewater volume increases.

On the other hand, the effluent-influent BOD_5 ratio has a coefficient of –0.1233 with a standard error of 0.7562. This implies that cost is expected to decrease as BOD_5 effluent-influent ratio increases. The dummy variables have standard errors ranging from 0.0932 to 0.3909.

To estimate total abatement costs, Equation 4 is used and together with the derived coefficients, cost estimations and several simulations are done to estimate the policy implications of implementing an effluent charge scheme at Sarangani Bay.

$$C = e^{\alpha 0} W^{\alpha 1} [E\backslash I]^{\beta 1} \qquad \text{Equation 4}$$

The marginal abatement cost (MAC) is estimated by taking derivatives of the abatement cost with respect to BOD_5.

$$\frac{C}{E} \qquad E^{\alpha 0} W^{\alpha 1} [E/I]^{\beta 1} \qquad \text{Equation 5}$$

For a specific effluent charge p, conversion of Equation 5 to an emissions/effluent response function is straightforward under the assumption of cost minimization. A cost-minimizing plant would equate p1 to (dC/dE), given the volume of wastewater and influent for pollutant 1. This yields the following emissions/effluent equation:

$$E_1 = \left[\beta_1 e^{\alpha_0}\right]^{\frac{1}{1-\beta_1}} W^{\frac{\alpha_1}{1-\beta_1}} p_1^{\frac{-1}{1-\beta_1}} I_1^{\frac{-\beta_1}{1-\beta_1}} \prod_{i=2}^{4} \left[\frac{E_i}{I_i}\right]^{\frac{\beta_i}{1-\beta_1}} \qquad \text{Equation 6}$$

4.3 Ex-Ante Evaluation of Effluent Charge

4.3.1 Marginal Abatement Cost Variations

The advantage of using economic instruments over a pure command and control scheme relies largely on the efficiency gains that can be derived from confronting all polluters with an identical price of “polluting at the margin”.

Compliance under the CAC scheme is considered to be costly because polluters with high abatement costs are required to undertake as much abatement as those with lower costs. Making all polluters face the same regulations allows for little flexibility in meeting a target level of reduction. The wide range of variability of marginal abatement costs (MAC) among industrial plants is important for it is the existence of this variability that provides justification for replacing uniform pollution standards by effluent charges. In practice, these have to be large enough to convince policy-makers that the efficiency benefits of market-based instruments will outweigh the cost of transition to a new regulatory regime (Dasgupta et al. 1996).

Consistent with other local and international literature on industrial pollution abatement costs, results show large magnitudes of variations in marginal abatement costs. Table 11 shows that MAC of the 12 sectors discharging wastewater at Sarangani Bay ranges from Pesos 1.63 to Pesos 68.52/kg BOD_5 (USD 0.03 to USD 1.29/kg BOD_5). Certain distinct abatement cost behavior can be deduced from the results. For instance, the MAC of BOD_5 reduction is generally higher, the smaller the scale of the plant such as the case of grain processing which registered the highest MAC among the twelve sectors.

Table 11. Total and Marginal of Controlling BOD_5 Discharges of Major Industrial Polluters

Sector	*BOD_5 (t/year)* [1]		*Total Cost*[2]	*MAC*[2]
	Influent	*Effluent*	*('000Pesos/year)*	*(Pesos/kg BOD_5)*
Hog Raising	4,310	2,155	267,545	16.39
Slaughtering	47	23	3,240	17.91
Poultry Dressing	85	42	3,220	20.66
Tuna Canning	7,270	3,782	204,965	7.53
Fish & Other Seafood Processing	195	98	10,556	31.44
Production of Fishmeal	13	7	99	1.81
Grain Processing	.6	.3	162	68.52
Beverage	291	146	25,651	21.70
Production of Crude Coconut Oil	1,231	615	19,154	3.84
Banana Chips Mfg.	20	10	417	5.25
Paper Products Mfg.	975	487	6,433	1.63
Fish port Complex	193	35	5,360	18.71
Total/Average	14,631	7,401	546,804	18

[1] Major industrial polluters refer to the 68 large establishments.

[2] In 1998 prices at base year 1994

From Equation 5 above, Table 12 shows the varying marginal abatement cost (MAC) for the plants in the 12 sectors considering nine (9) abatement rates.

Comparing MAC of different sectors given the same abatement rate, the ratio is as high as 42:1. While comparing plants belonging to the same industry sector, at constant abatement rates, estimated ratio is 9:1[2]. Looking at the same sector, at varying

[2] Only five(5) out of the 12 industry sectors considered in the study consist of several plants/establishments (Table 1). Out of these five sectors, two have varying MAC where the 9:1 ratio is based.

abatement rate, the registered ratio is 12:1 for 90% and 10% abatement. The last comparison implies that as MAC increases, the greater is the level of pollution reduction.

Table 12. Sectoral Marginal Abatement Cost by Rate of Control

Sector	*MAC by Rate of Abatement (Pesos/kg)**								
	10%	*20%*	*30%*	*40%*	*50%*	*60%*	*70%*	*80%*	*90%*
Hog Raising	8.5	9.7	11.2	13.4	16.4	21.1	29.1	45.9	99.9
Slaughtering	9.3	10.6	12.3	14.6	17.9	23.0	31.8	50.1	109.2
Poultry Dressing	10. 7	12.2	14.2	16.8	20.7	26.5	36.7	57.8	126.0
Tuna Canning	4.0	4.6	5.4	6.4	7.8	10.1	13.9	21.9	47.7
Fish & Other Seafood Processing	16.3	18.5	21.6	25.6	31.4	40.4	55.8	88.0	191.7
Production of Fishmeal	0.93	1.1	1.2	1.5	1.8	2.3	3.2	5.1	11.0
Grain processing	35.4	40.4	47.0	55.8	68.5	88.0	121.6	191.8	417.8
Beverage	11.2	12.8	14.9	17.7	21.7	27.9	38.5	60.7	132.3
Production of Crude Coconut Oil	1.9	2.3	2.6	3.1	3.8	4.9	6.8	10.7	23.4
Banana Chips Mfg.	2.7	3.1	3.6	4.3	5.3	6.8	9.3	14.7	32.0
Paper Products Mfg.	0.84	0.96	1.1	1.3	1.6	2.1	2.9	4.6	9.9
Fish port Complex	3.1	3.6	4.2	4.9	6.1	7.8	10.8	17.0	37.0

* In 1998 prices at base year 1994

53 Pesos = 1USD

4.3.2 Setting the Appropriate Charge to Meet Ambient Standard

Effluent charge forces the industries to consider as part of their production cost the damages imposed by their pollution discharge. Under this scheme, polluters are not told what to do; rather, they are given the opportunity to choose the least expensive option. Considering the profit maximizing behavior of firms, if effluent charges are set too low, industry has no inducement to reduce pollution, but if they are set too high, they can incur strong political opposition and/or industries may be induced to illegally dispose their wastes.

In theory, setting the effluent charge at the level of marginal cost of damage from pollution or MAC is the best way to internalize the social costs of pollution and change the behavior of economic agents (Baumol and Oates 1988).

Given the complexity of doing a damage valuation exercise for pollution discharges in the Bay, the study uses a proxy value for the damage assessment. The study assumes that compliance with the ambient standard set by DENR would bring the level of pollution discharge to Sarangani Bay at a non-damaging level.

If all industries (i.e. 68 establishments covered in the study) comply with the effluent standard, it would effectively generate a significant level of industrial pollution reduction at approximately 98%. (Table 9) This level of abatement is greater than what is needed to meet ambient (Class SB) standard. For this study, the effluents charge is based on meeting the minimum reduction needed, i.e. 6,114 t/year or 92% industrial influent reduction, but not necessarily capable of complying with the effluent standard (Table 9).

To arrive at the efficient level of charge that would meet the DENR Class SB ambient requirement, several simulations were done. Equation (6) (in Section 4.2) is applied plant-by-plant to predict the effluent concentration and emissions given by different levels of effluent charges. Table 13 shows the results of these simulations. Using these results on the expected level of emissions given a certain level of charge, and then matched with the plant level's influent concentration and wastewater volume, equation (5) is then applied to get the total abatement cost per plant. The pollution abatement or reduction rate for each effluent charge level was also calculated using the results from equation (6) and the plant level's influent concentration (Table 13).

Table 13. Cost of Abatement for Different Levels of Effluent Charges

Charge [Pesos(USD)/kg BOD_5]	BOD_5 (t/yr)		% Reduction	Cost of Abatement ['000 Pesos (USD)/year][1]
	Influent	Effluent		
Existing	14,630	7,401	49.41	546,804 (10,317)
5 (0.09)	14,630	1,391	90.49	657,940 (12,413)
6 (0.011)	14,630	1,183	91.92	671,240 (12,664)
7 (0.13)	14,630	1,031	92.95	682,695 (12,881)
8 (0.15)	14,630	915	93.74	692,776 (13,071)
9 (0.17)	14,630	824	94.37	701,791 (13,241)
10 (0.19)	14,630	750	94.87	709,954 (13,395)
15 (0.28)	14,630	523	96.42	742,266 (14,005)
20 (0.38)	14,630	405	97.23	766,080 (14,454)
25 (0.47)	14,630	332	97.73	785,077 (14,812)
30 (0.57)	14,630	282	98.07	800,497 (15,103)
35 (USD0.66)	14,630	246	98.32	814,615 (15,370)
40 (0.75)	14,630	218	98.51	826,644 (15,597)

Continued

Table 13 continued				
45 (0.85)	14,630	197	98.66	837,401 (15,800)
50 (0.94)	14,630	179	98.78	847,142 (15,983)
55 (1.04)	14,630	165	98.88	856,051 (16,152)
60 (1.13)	14,630	152	98.96	864,267 (16,307)

[1] In 1998 prices at base year 1994

Given the environmental target and results of the simulations, a Pesos 6 (USD 0.11)/kg BOD_5 effluent charge level is sufficient to realize the needed industrial pollution reduction (i.e. 92%) in order to meet the Class SB ambient standard. Total abatement cost at this level of pollution reduction and charge is Pesos 671 million (USD 12.66 million). Implicit in this level of pollution charge is that the MACs for all industrial plants are equal since each polluter abates to the point where their MAC equals the set charge. This is consistent with the equi-marginal principle of optimality.

4.3.3 Impact of the Estimated Effluent Charge

In this section, Equations (4) - (6) are used to analyze the implications of moving towards an economic instrument regime as a management tool for Sarangani Bay.

As stated in the earlier chapter, the ultimate objective of introducing an improved environmental management tool in the form of effluent charge is not simply to reduce the level of pollution discharge at any arbitrary level. It is aimed to protect and maintain good water quality of Sarangani Bay (via compliance with Class SB ambient standard).

Pure CAC vs. CAC with Effluent Charge

The main intention of the study is to evaluate, in terms of cost efficiency and environmental effectiveness, the merits of moving from a pure CAC to a policy regime that compliments CAC with EI. Table 14 shows that a change from the existing effluent level to the effluent level that is in compliance with Class SB (i.e. 7,401 t/year to 1,287 t/year of BOD_5) generates a 42% increase in pollution reduction (from 49% to 92% level of reduction) with only a 23% increase in total abatement cost from Pesos 547 million to Pesos 671 million (USD 10.32 million to USD 12.66 million) under an effluent charge scheme. But without the effluent charge scheme, if the same level of industrial pollution reduction (i.e. 92%) would be achieved under a pure CAC scheme, total abatement cost would amount to approximately Pesos 685 million (USD 12.92million). This implies that achieving the same level of pollution reduction target is approximately Pesos 14 million (USD 264,150) (2%) more expensive under the existing CAC scheme than under a scheme that compliments CAC with effluent charge.

Table 14. Comparison between the Abatement Costs of the Existing CAC and CAC with Effluent Charge Scheme

Scheme	*Effluent* (*t/year*)	*BOD_5 Reduction* (*%*)[1]	*Abatement Costs* (*'000 Pesos/year*)
Existing Scenario	7,401[2]	49	546,804[3]
Environmental Target: Compliance with Class SB Ambient Standard			
Option A: Existing CAC Scheme	1,287[4]	92[4]	685,141
% Increment from Existing[5]	(83)		25
Option B: CAC w/ Effluent Charge (Pesos6/kg)	1,287[4]	92[4]	671,240[6]
% Increment from Existing[5]	(83)		22
Other Scenarios			
DENR's Proposed Discharge Fee	523	96	742,266
% Increment from Existing	(93)		36
Compliance w/ Effluent Std	221[4]	98[4]	833,200
% Increment from Existing[5]	(97)		52

Note: 53 Pesos = 1 USD

[1] Computed given an influent level of 14,630 t.

[2] Figure derived from Table 5.

[3] Figure derived from Table 11.

[4] Figure derived from Table 9.

[5] % Increment = (Target-Existing)/Existing

[6] Figure derived from Table 13

In the light of the MAC variations discussed above, a Pesos 14 million (USD 264,150) abatement cost savings may appear to be inconsistent in satisfying the cost-efficiency criterion.

Several considerations in the study are worth emphasizing at this point:

a) As mentioned earlier in the report, the 68 establishments or the 12 industry sectors considered in the study are recognized as the major contributors of pollution in Sarangani Bay by virtue of the focus of DENR monitoring and as pointed out by previous studies.

b) Among these 68 establishments, there are only two major industry sectors, i.e. tuna and hog sectors which significantly dominate (approximately 80%) BOD loadings from the industrial sectors (refer Table 5). All the other industry sectors contribute an average of 1 – 2% share of BOD discharges to Sarangani Bay.

c) Across plants or firms in these two industry sectors, MAC does not vary much; for hog sector MAC ranges from Pesos 15-17/kg (USD 0.28 – 0.32/kg) and for tuna sectors MAC falls between Pesos 3-6/kg (USD 0.06 – 0.11/kg) (except for one firm). Given the little variations of MAC across plants within the same industry classification for these two sectors, there was only a little potential for cost savings, i.e. the potential for low cost abater to do much of the abating. However, across these two sectors - true to its market orientation - results showed that in the presence of an effluent charge, the higher cost abater i.e. hog sector, was induced to allow the lower cost abater, i.e. tuna sector, to do more of the abating. Based on the simulation, under a pure CAC scheme, hog sector will be discharging 344t BOD_5/year in Sarangani Bay. Under a scenario where CAC was complemented with effluent charge, hog sector found it cheaper to pay the charge instead of abating; hence their discharge was increased to 593 t/year. This increase in pollution loading was offset by the increased level of abatement done by the tuna sector at a cheaper cost.

d) For the other industry sectors, since only a little pollution contribution are attributed to them, even with the variability of MAC across these sectors and across plants, their pollution reduction potential and hence, the potential abatement cost saving that they can contribute is not very significant.

e) Points (c) and (d) provide the basis on why potential cost savings from complementing CAC with effluent charge appear minimal.

f) It should be noted that the study utilized a simple deterministic model. This means that there was no forecasting or simulations done to capture the dynamic changes that could potentially occur in the economy and the environment. SOCSARGEN, especially General Santos City with its vast resources, remains a strong economic growth area in the country. With the potential advent of other industries and the growth of existing industries, this will lead to an inevitable growth of pollution discharges. Under such an economic scenario if the status quo (i.e. pure CAC) remains on the arena of environmental management, the study does not foresee significant technological advancement in production, more so in pollution abatement. Hence, the MAC variation analysis discussed above remains true. In this case, environmental management within the realm of CAC with effluent charge may generate further significant cost savings as illustrated in the case of tuna and hog sectors. This scenario is the reason why the study opted to retain the discussion on MAC variations above despite the seemingly insignificant potential cost savings from the existing industry sectors at present.

Comparing the absolute value of Pesos 14 million (USD 264,150) abatement cost savings in other countries may not provide sufficient incentive to warrant complementing CAC with an effluent charge scheme. But in the light of the environmental situation in Sarangani Bay vis-à-vis the current dismal state of environmental management in the country, there is a need to take a proactive stance regarding environmental targets but also founded on the basis of achieving economic efficiency realistically. In a developing country like the Philippines, the relative value of every centavo is greater than in a developed country and any potential additional source of funds should be seriously considered. At the current situation under a pure CAC policy scheme, since DENR and EMB in particular, gets a meager share in the national budget, it is not attainable to provide sufficient manpower and technical resources to enhance enforcement and monitoring to ensure that a 92% industrial pollution reduction will be achieved. Whereas if CAC will be complimented with effluent charge scheme, a certain proportion of revenue from pollution charges could be used to cover the implementation cost and/or used for self-construction of environmental protection agencies. This way, polluters are made to pay for the externalities they generate. Economic instruments or other instrument, for that matter, cannot deliver its promise of economic efficiency if the instrument cannot be enforced effectively. Hence, in the light of the wider realm of achieving economic efficiency and environmental effectiveness in environmental management, Pesos 14 million is still a better option.

Other Scenarios: Effluent Charge vs. DENR's Proposed Wastewater Discharge Fee and Compliance with Effluent Standard

As consistently emphasized in the study, the ultimate objective of complementing CAC with effluent charge is to ensure that pollution discharges are limited to a level that Philippine waters would be suitable to protect the beneficial usages intended for those waters, that is, comply with the ambient standard. But in the light of existing and proposed laws of the land, the study also considered a scenario wherein all firms comply with the effluent standard and another scenario where DENR's proposed wastewater discharge fee is implemented.

Results show that if all 68 establishments comply with effluent standards, the level of BOD_5 being discharged into the Bay would be reduced to 221 tonnes which is equivalent to a 98% pollution reduction, while the DENR's proposed fee of Pesos 15 (USD 0.28)/kg BOD_5 BOD_5 (Appendix 6) would result in a 96% reduction of industrial BOD_5 or 523 tonnes (Table 14). Complying with the effluent standard is equivalent to setting the effluent charge to Pesos 40 (USD 0.75) /kg BOD_5 with a total abatement cost of Pesos 827 million (USD 15.60 million) (Table 13) while in the latter scenario, corresponding total abatement cost is Pesos 742 million (USD 14 million).

In both scenarios, the level of industrial pollution reduction is significantly greater than what is really needed to protect or maintain the ambient condition of the Bay. The lower level of pollution discharge naturally translates to greater abatement cost (compliance to effluent standard: 23% higher and DENR fee: 11% higher), beyond the efficient level and hence, considered overly burdensome to the industry sector and to society in general.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study assessed, in terms of cost savings and pollution discharge reductions, the use of effluent charge scheme as a management tool for protecting and maintaining good water quality in Sarangani Bay.

The study assumed that compliance with the ambient standard (Class SB) set by DENR would bring the level of pollution discharge to Sarangani Bay at a non-damaging level. This standard of maintaining a maximum BOD_5 ambient level of 5 mg/L was then used as the basis for setting the effluent charge level. To do this, the ambient requirement was converted in terms of mass (t) through a deterministic water quality assessment model, to determine the allowable pollution discharge to the Bay. Results showed that Sarangani Bay could assimilate as much as 19,134 t of BOD_5 annually without exceeding the ambient standard for Class SB. Since annual pollution discharge in the bay is approximately 25,248 t, a reduction of 6,114 t BOD_5 is needed in order to meet the allowable discharge level.

Given the existing annual discharge of the industrial sector, focusing on requiring the necessary reduction from this sector alone would be sufficient to meet Class SB standard. If the industrial sector is to respond to this required reduction, the level of abatement should increase from the existing 49% to 92%. If all industries will comply with the effluent standard, the rate of reduction (98%) that will be realized is more than what is required to meet Class SB ambient standard.

Based on the econometric simulations conducted, analysis and evaluation of effluent charge were carried out:

- Results show a large magnitude of variation in marginal abatement costs, which implies efficiency benefits in moving towards a market-based scheme in pollution control.

- Pesos 6 (USD 0.11)/kg BOD_5 effluent charge level is sufficient to realize the needed industrial pollution reduction (i.e. 92%) in order to meet the Class SB ambient standard.

- A change from the existing effluent level (under CAC scheme) to the effluent level that is in compliance with Class SB would generate a 42% increase in pollution reduction (from 49% to 92% level of reduction) with only a 23% increase in total abatement cost (from Pesos 547 million to Pesos 671 million) (USD 10.32 million to USD 12.66 million respectively). If the same level of industrial pollution reduction (i.e. 92%) could be achieved under a pure CAC scheme, total abatement cost would amount to approximately Pesos 685 million (USD 12.92 million). This implies that achieving the same level of pollution reduction target is approximately Pesos 14 million (USD 264,150) more expensive under the existing CAC scheme than under a scheme that complements CAC with effluent charge.

- Setting the effluent charge to Pesos 15 (USD 0.28)//kg based on DENR's proposal would result in a 96% reduction of industrial BOD_5 and a corresponding total abatement cost of Pesos 742 million(USD 14 million). This cost is 11% higher (equivalent to Pesos 71 million or USD 1.34 million) than the cost required to meet the Class SB ambient standard on the basis of setting the effluent charge at Pesos 6 (USD 0.11)/kg.

- Complying with the effluent standard is equivalent to setting the effluent charge to Pesos 40 (USD 0.75)/kg BOD_5 in order to achieve a 98% pollution reduction or an effluent level of 218 t. This level of reduction would entail a total abatement cost of Pesos 827 million (USD 15.60 million) which is 23% higher than the cost of meeting ambient standards but only 7% higher in terms of pollution reduction.

The considerations associated with direct regulation also apply to economic instruments. There is still a need to know what the harmful level is and the need for monitoring and enforcement remains. These factors also serve as the main argument that favors economic instruments over a pure CAC scheme. Economic instruments, or other instruments, cannot deliver its promise of economic efficiency and achievement of environmental goal if the instrument cannot be enforced effectively. It is far from attainable under a pure CAC scheme to allocate sufficient manpower and technical resources to enhance enforcement and monitoring to ensure that a 92% industrial pollution reduction can be achieved. Whereas if CAC is complemented with an effluent charge scheme, a certain proportion of revenue from pollution charges could be used to cover the implementation cost and/or used for the self-construction of environmental protection agencies. Hence, in the light of the wider realm of achieving economic efficiency and environmental effectiveness in environmental management, Pesos 14 million (USD 264,150) abatement cost saving may not be as significant compared to the experiences of other countries; it is still a better option.

The study further concludes that if the overriding goal is to protect the ambient water quality of Sarangani Bay, going beyond the needed pollution reduction through the enforcement of effluent standard or the proposed DENR pollution fee would be overly burdensome to the industry sector and the society in general. The environmental benefits would probably not be enough to make the extra expense worthwhile.

5.2 Recommendations

There are six major points recommended by the study:

i) Considering the existence of large numbers of small and domestic pollution sources which are known to contribute a major portion to pollution discharges but where instruments such as effluent charge are hard to implement and monitor, water taxes and product charge schemes should be explored.

   Since the sewage system is seriously being considered as one of the major infrastructure projects at General Santos City, a user charge for municipal or collective wastewater treatment with differentiated tariffs for industries and households should be explored and evaluated. Water charging is another option that can be considered since water usage is metered in most of the areas in General Santos City and Sarangani Province. A water charge may possibly provide an incentive to reduce water use and the corresponding pollution.

ii) In the light of DENR’s plan to implement the wastewater discharge permit fee system nationwide, it would be warranted to assess and evaluate the implications (economic and environmental considerations) of requiring industries to simultaneously meet both the ambient and effluent standards, particularly in instances where the protection of a particular body of water (e.g. Sarangani Bay) is the point of concern.

iii) Taking into consideration the results in this study, the implementation of a uniform effluent charge may not be optimal since local conditions vary. It might therefore be more efficient for DENR to just set the official effluent charge at a ‘reference level’ and let the officials in the local government units and other regional stakeholders, under the leadership of EMB Regional Offices, make the necessary adjustments in ways that they perceived more effective to achieve the environmental goal.

DENR, and in particular EMB central office, should remain the one to set up the general requirement of regulation according to the environmental laws but it should be the regional level EMB units and LGU’s (local government units) responsibility to enforce and improve the regulation set by the National government.

iv) A myopic view of the mechanisms and the actors (stakeholders) and factors that affect pollution reduction performance, may pave the way for an over-hasty implementation of MBIs which might lead to the discrediting of these regulatory tools. Appropriate consultation and cooperation during the design and implementation stages of the instrument should be done to ensure the acceptance and effectiveness of the instrument. In connection with this, it should be recognized that the regulators are not the only major actors in the larger scheme of environmental regulation.

The environmental performance of factories is determined by the interactions of multiple agents with multiple incentives. Although DENR can and should have a continuing role in the regulation of pollution externalities, the importance of community and market should be equally recognized (Afsah, Laplante and Wheeler 1996). Public disclosure programs offer significant empowerment to local communities in this context.

v) One advantage of MBI, from a financial perspective, is that it generates revenues. In principle, there are two general options in using the proceeds of environmental revenues: the monies can be (1) added to the national budget and the government can make the decision on what the investment “winners” are; or (2) earmarked for certain projects including a partial or whole return to the regulated industries (with certain conditions attached).

Since the Philippines is adopting the “single fund” concept where all revenues go to the treasury and are allocated through the appropriation process, earmarked revenue has to go through a tedious process before the money can be used as intended. EMB and other stakeholders need to actively lobby for politicians’ approval to ensure that they will get the funds that they had proposed for certain priorities and projects. Changes and improvements are expected once the “Clean Water Act” is enacted and a special trust fund is expected to be created.

Nevertheless, whether the funds will be placed under the existing General Appropriations Act or the proposed special trust fund, the study proposes that the revenue from effluent charges be earmarked. For one, the regulated community's abatement performance is anticipated to improve if it can benefit from re-cycling of the charges. Furthermore, at a political level, earmarking makes it easier to build consensus, remove barriers, and guarantee budget resources to finance environmental institutions.

In the likely event that DENR's revised wastewater permitting system will be implemented, the pollution charge will therefore be linked to existing collection mechanisms. Under this scenario, EMB Regional Offices (ROs) will be the implementing arm of the permitting system. Besides the implementation task, EMB ROs, in close consultation with other stakeholders (e.g. LGUs, NGOs, POs), should also be given the leeway to earmark the revenues collected.

A guideline should be prepared by EMB Central Office to serve as a basis for Regional Offices (Ros) in establishing collaboration (through a MOA) with LGUs in areas of setting environmental goal, adjusting the "reference charge level" and earmarking the revenue.

Following are some examples for earmarking revenues to specific environmental programs**:**

i) Finance environmental institutional development, administration and environmental projects.

ii) Subsidize firms' pollution control projects. For instance in China, a maximum of 80% of the levy paid by the firm can be used to subsidize the investment project proposed by the firm (Wang – WB website)

iii) They might also be directed to assist those who are economically hurt by the change to a system of implementing charges.

vi) Water quality monitoring procedures should be reviewed, evaluated and revised.

Since vertical mixing is not a significant phenomenon at Sarangani Bay and hence organic waste just stays at the surface, monitoring activities that are usually conducted offshore naturally generate consistently good water quality results. Water quality studies and ambient monitoring activities should take this natural characteristic of Sarangani Bay into consideration to generate a more realistic assessment of the Bay. Ambient monitoring activities should be reviewed and taken into consideration.

Furthermore, the current regulatory standards and monitoring procedures of industrial effluents are based on concentration. A shift to weight-based standards would require strict monitoring not just of pollution concentrations but also of discharge flow rates.

REFERENCES

ADB (Asian Development Bank) Environment Division. 1997. Potential Uses of Market-Based Instruments for Environmental Management in the Philippines. ADB, Philippines.

______. 1997. Strategy for the Use of Market-Based Instruments in Indonesia's Environmental Management. ADB, Philippines.

Afsah, S., B.Laplante, and D.Wheeler. 1996. Controlling Industrial Pollution: A New Paradigm. Policy Research Working Paper 1672, World Bank, Washington D.C.

Baumol, W., and W.Oates. 1988. The Theory of Environmental Policy (Second ed.). Cambridge University Press.

Beder, S. 1993. The Nature of Sustainable Development. Scribe Publications, Australia.

Callan and Thomas. 1996. Environmental Economics and Management: Theory, Policy and Applications. Times Mirror Higher Education Group, Inc.

CPDO (City Planning and Development Office). 2000. Physical Framework Plan of General Santos City. CPDO, Gen. Santos City.

CRMP (Coastal Resource Management Project). 2002. 2001 Sarangani Bay Integrated Coastal Management Plan. USAID, Philippines.

Dasgupta, S., M. Huq, D.Wheeler, and C. Zhang. 1996. Water Pollution Abatement by Chinese Industry: Cost estimates and Policy Implications. WB Policy Research Working Paper 1630. Washington D.C.

Ebarvia, M.C. 1994. Estimation of Environmental Damages. Environmental and Natural Resources Accounting Project Phase III, Manila.

Francisco, H., M. de los Angeles, R. Bagarinao, A. Calara, A. Indab, and T. de Guzman. 1997. Economic Development, Population Growth and the Environment in SOCSARGEN, Mindanao, Philippines. Environmental and Natural Resources Accounting Project Phase 4-A, Manila.

IEMP. 1997. Final Report on the Initial Water Quality Assessment of Sarangani Bay.

Lamb, J. 1985. Water quality and its control. John Wiley and Sons New York.

LB11(Louis Berger International, Inc.) 1991. Framework for the Coastal Area Management Plan of Sarangani/General Santos City. USAID, Manila, Philippines.

Viesmann Jr., W. and M. J.Hammer. 1993. Water Supply and Pollution Control (Fifth ed). Harper Collins College Publishers, New York.

Wang, H. (www.worldbank.org). Pollution Charges, Community Pressure and Abatement Cost of Industrial Pollution in China.

Woodward-Clyde Philippines, Inc. 1996. Initial Assessment of Sarangani Bay (Draft Report). PRC-Environmental Management, Inc., Manila, Philippines.

Appendix 1. Ambient and Effluent Standards for Sarangani Bay and Its Tributaries

Pollutant	Ambient Standard (mg/L)			Effluent Standard (mg/L)				
	Class SA	Class SB	Class C	Class SA	Class SB		Class C	
					OEI	NPI	OEI	NPI
BOD_5	3	5	7	(c)	50	30	80	50
SS	(a)	(b)	(b)	(c)	70	50	90	70

Notes:

(a) Not more than 30% increase

(b) Not more than 30 mg/L increase

(c) Discharging of sewage and/or effluent is prohibited or not allowed.

OEI Old or Existing Industry

NPI New/proposed Industry

Reference: DAO 34 and 35

There are two applicable water quality standards for the control of pollution, one is the ambient standard and the other is effluent standard. Water classification for these standards are arranged in the order of the degree of protection required, with Class SA having generally the most stringent water quality for marine/coastal waters and Class C has less stringent water quality requirement for fresh surface water.

For new/proposed industries (NPI), the effluent standard is more stringent than for old or existing industries (OEI).

Appendix 2. Policy Actions for the Pollution and Water Quality Control Component of ICMP

Actions	*Implementing Agencies*		*Funding (Pesos)*		*Year of Implementation*				
	Lead	*Support*	*Amount Required*	*Source*	*1*	*2*	*3*	*4*	*5*
Baseline information gathering	DENR -EMB	Provincial/ City/Municipal LGUs, Academe			X				
Establishment of water quality laboratory and monitoring system	Provincial/City LGUs	DENR			X	X			
Economic analyses of environmental costs	Provincial/City LGUhs	Municipal LGUs, Academe			X	X			
Conduct of environmental policy research studies and application of market-based instruments for pollution control	Provincial/City LGUs	DENR, Private sector				X	X		
Construction of appropriate pollution control devices	Provincial/City LGUs	DENR, Private sector				X	X	X	
Conduct of IEC activities that also include concerns on policies and standards	PAMB	Provincial/ City/Municipal LGUs, DENR, FARMCs, IATFCEP			X	X	X	X	X

Source: 2001 Sarangani Bay Integrated Coastal Management Plan

Appendix 3. Population of Sarangani Province and General Santos City

Coastal Municipality	*Total Number of Barangays*	*Population*				*Density*
		1990	*1995*	*2000*	*Growth Rate (%)*	*(no./km^2.*
Sarangani Province	140	283,141	367,006	428,170	5.33	104
Alabel	12	40,730	46527	52,045	2.70	105
Glan	31	60,382	73,768	82,760	4.09	119
Kiamba	19	35,418	39,717	44,023	2.32	105
Maasim	16	26,734	31,614	34,615	3.43	54
Maitum	19	25,640	35,009	37,501	6.43	116
Malapatan	12	36,255	47,911	54,208	5.73	87
Malungon	31	57,982	92,433	123,018	9,78	137
General Santos City	26	250,389	327,173	427,503	5.50	797
TOTAL	166	533,530	694,179	855,673	5.41	185

Appendix 4. BOD_5 Abatement Costs for Selected Industries, 1992

Industry	*Requiring Primary & Secondary WWT*	*Requiring Additional Secondary WWT*
Food processing	4.3 – 53.8 (USD0.08-1.02)	3.6 – 205.3 (USD0.07-3.87)
Piggeries	5.6 – 67.7 (USD0.11-1.28)	32.3 – 518.5 (USD0.61-9.78)
Beverage production	16.3 – 72.2 (USD0.31-1.36)	4.5 – 190.6 (USD0.08-3.60)
Dyes and Textiles	7.7 – 142.7 (USD0.15-2.69)	4.9 – 320.0 (USD0.09-6.04)
Chemicals	6.8 – 53.8 (USD0.13-1.02)	20.3 – 280.0 (USD0.38-5.28)

Source: ADB-Environment Division. 1997. Potential Uses of Market-Based Instruments for Environmental Management in the Philippines. ADB, Philippines.

Units are in Pesos/kg BOD_5 with USD in brackets.

Appendix 5. Regression Results

Variable	*DF*	*Parameter Estimate*	*Standard Error*
Intercept	1	1.967105	0.35132116
LWW	1	0.935594	0.06541505
LBOD	1	-0.123305	0.75621388
Slaughtering	1	-0.179540	0.13145548
Poultry Dressing	1	-1.098261	0.15079349
Tuna Canning	1	-0.057558	0.10738272
Fish and Other Seafood Processing	1	-0.198548	0.09319519
Production of Fishmeal/Prawn feeds	1	0.160186	0.24060246
Corn Milling	1	-2.744858	0.21120901
Beverage Manufacturing	1	-0.086562	0.21932865
Production of Crude Coco Oil, Copra Cake, Meals & Pellets	1	-1.071836	0.22603783
Banana Chips Mfg.	1	-0.773287	0.21533277
Mfr. of Paper Products	1	2.080403	0.21608588
Fish Port Complex	1	-1.552477	0.39087088
No. of Observation	68		
Adj R-sq	.9190		

Note: DF – degree of freedom

LWW – log of wastewater

LBOD – log of BOD

Mfr. - manufacture

Appendix 6. DENR's Wastewater Discharge Permit Fee Scheme

This fee refers to the total fee paid by a discharger for the use of water body for wastewater disposal purposes.

Computation of the total discharge fee is as follows:

$$Df_i = F_i + LBF$$

Where: Df_i = total wastewater discharge permit fee per establishment or facility i

F_i = administrative fee per establishment or facility i per year

LBF = pollutant load-based fee

The load-based fee is based on this formula:

$$LBF = \sum_{j=1}^{n} [(Rj \times Lj) \times Sj]$$

where: n = number of pollutants

Rj = rate of charge per unit of pollutant load by pollutant j (in PESOS/unit of pollutant load)

$Lj = (Cj \times Qj \times N) / 10^6$ (in kg) or the pollutant load j

Pollutant load or Lj refers to the product of the establishment effluent concentration (in mg/L), Cj, volumetric flow rate (in liters per day), Qj, and the number of operating days in a year, N.

The correction factor for the differences in ambient water quality or the stream factor is computed as follows:

$$Sj = 1 - (A_t / A_c)$$

where: A_c = the current ambient environmental quality of the receiving river or water body

A_t = the target ambient environmental quality based on the river or water body classification under DENR Administrative Order No. 34, Series of 1990.

Appendix 7

GLOSSARY

ADB	Asian Development Bank
BOD_5	Biochemical oxygen demand
CAC	Command and Control
CPDO	City Planning and Development Office
CRMP	Coastal Resource Management Project
DAO	Department Administrative Order
DENR	Department of Environment and Natural Resources
DO	Dissolved Oxygen
EI	Economic Instrument
EMB	Environmental Management Bureau
ENR	Environment and Natural Resource
ENRAP	Environmental and Natural Resources Accounting Project
EOP	End-of-Pipe
E. coli	Escherichia coli
GSC/GenSan	General Santos City
LGU	Local Government Unit
ICMP	Integrated Coastal Management Project
IPPS	Industrial Pollution Projection System
IEMP	Industrial Environment Management Project
IEPC	Industrial Environment and Pollution Control Project
LGU	Local Government Unit
LWK	Live-weight Killed
M	Million
MAC	Marginal Abatement Cost

MBI	Market-Based Instrument
MOA	Memorandum of Agreement
MSU	Mindanao State University
NGO	Non-Government Organization
NIPAs	National Integrated Protected Areas System
NPI	New/Proposed Industry
NSO	National Statistics Office
OEI	Old/Existing Industry
PAMB	Protected Area Management Bureau
PCO	Pollution Control Officer
Pesos	Philippine Peso
Phil	Philippines
PO	People's Organization
RO	Regional Office
SS	Suspended Solids
SOCSARGEN	South Cotabato-Sarangani-General Santos City
t	Metric Tonne
TWG	Technical Working Group
WB	World Bank
WHO	World Health Organization
WW	Wastewater
WWT	Wastewater Treatment